# The Engineer

LONDON, FRIDAY, AUGUST 22, 1941.


PUBLIC NOTICES

## THE TEES VALLEY WATER BOARD

THE PROVISION AND INSTALLATION OF VENTURI METER AND RECORDERS

Contractors with Experience in the Provision and Installation of Venturi Meters and Recorders, who are desirous of TENDERING for the above-mentioned WORK, in accordance with the drawings, general and special conditions of contract, specification, schedule and other particulars prepared by the undersigned, are invited to MAKE APPLICATION for the DOCUMENTS, which will be ready for issue on Wednesday, 27th August, 1941.

Only contractors experienced in the class of work described in the specifications and who have provided and installed similar apparatus to operate in conjunction with chlorination plant may Tender.

The contractor whose Tender is accepted will be required to enter into a contract under seal prepared by the Board, and to provide a surety by an approved Guarantee Society.

A deposit of Two Guineas, which should be enclosed with the application for the documents, will be required. This sum is returnable upon the receipt of a bona-fide Tender, provided the Tender is not subsequently withdrawn.

Tenders, sealed within the envelopes provided by the Board, and not endorsed with any mark or name identifying the senders, will be considered only if received by the undersigned not later than 10 a.m. on the 10th September, 1941.

T. S. R. WINTER,
Assoc. M. Inst. C.E.,
Acting General Manager and Engineer.
Water Board Offices,
Corporation Road,
Middlesbrough. 7702

## BOROUGH OF TORQUAY

PUMPING PLANT

Tenders are Invited for the SUPPLY of an Electrically Driven CENTRIFUGAL PUMP with a delivery of 400 galls. per minute against a head of 210ft.

Details and conditions of contract may be obtained from the Water Engineer, Town Hall, Torquay.

Sealed Tenders, endorsed "Pump," to be received at my office by Monday, 8th September, 1941.

HERBERT A. HIELD,
7707 Town Clerk.

## NEWCASTLE AND GATESHEAD WATER COMPANY

APPOINTMENT OF AN ENGINEERING ASSISTANT

Applications are Invited for the APPOINTMENT of an ENGINEERING ASSISTANT, at a commencing salary of £400 per annum subject to deduction for Superannuation Fund.

Candidates should not exceed 35 years of age and should be Corporate Members of the Institution of Civil Engineers, and have had experience in the design, construction and maintenance of large waterworks, including experience in the maintenance of Impounding Reservoirs, Gravity and Mechanical Filtration Plant, Chlorination, Electric-driven Pumping Plant and Waterworks Distribution.

Applications, stating age, qualifications and experience, and accompanied by copies of three recent testimonials, should be forwarded in an envelope, endorsed "Appointment of Engineering Assistant," not later than 5th September, 1941, to the undersigned.

W. B. ATKIN,
Secretary and General Manager,
Newcastle and Gateshead Water Company,
7705 Pilgrim Street, Newcastle-on-Tyne, 1.

## CITY OF CARDIFF EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

Principal: JAMES STEPHENSON, M.A., M.Com., D.Sc.

DEPARTMENT OF ENGINEERING

Acting Head of Department: C. G. BEVAN, B.Sc., A.M.I.E.E.

SESSION 1941–42.
(Commencing on Tuesday, 30th September, 1941.)

The following courses have been arranged for Engineering Students:—

A three years' course in Civil, Mechanical and Electrical Engineering, jointly with the University College of South Wales and Monmouthshire;

A two years' "sandwich" course for apprentices and others having facilities for practical experience during the Summer Term.

The above courses are suitable for students preparing for a Degree in Engineering of the University of London and for the examinations of the professional engineering bodies.

Special courses are also arranged for Marine Engineers preparing for the examination of the Board of Trade.

Intending students may consult the Principal and Staff each morning between 10 and 12.30 o'clock from Monday, 8th September, onwards. Prospectuses of the separate Departments may be obtained upon application to the Principal.

SCHOLARSHIPS.

Open Scholarships, covering tuition fees and maintenance grants of £40 per annum for three years, will be offered for competition to residents of the City of Cardiff, the Administrative Counties of Glamorgan, Breconshire, Carmarthenshire, Monmouthshire, and Pembrokeshire, the County Boroughs of Merthyr, Newport, and Swansea, and the Administrative Area of the Rhondda Urban District Council. Forms of application to sit the Scholarship examination, which commences on Monday, 15th September, 1941, at 10 a.m., are obtainable from the Principal and must be returned to him, duly completed, on or before Thursday, 11th September, 1941.

W. J. WILLIAMS,
City Hall, Director of Education.
Cardiff. 7703

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

## The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE
ARRANGED FOR CARD INDEXING
(TABLE OF CONTENTS, PAGE 120)


The Natchez-Vidalia Bridge—No. II (P. 114)
THE ENGINEER, 22 - 8 - 41

Direct Injection *v.* Carburetter (P. 120)
THE ENGINEER, 22 - 8 - 41

Air Force Targets in Germany No. XXII (P. 117)
THE ENGINEER, 22 - 8 - 41

Combustion of Tar and Its Products (P. 122)
(W. KIRBY) THE ENGINEER, 22 - 8 - 41

Civil Airport Development in the United States No. I (P. 116)
THE ENGINEER, 22 - 8 - 41

Reinforced Concrete Barges (P. 124)
THE ENGINEER, 22 - 8 - 41

Light-Weight Steam Plant (P. 121)
(R. C. McLEOD) THE ENGINEER, 22 - 8 - 41



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*INDEX TO ADVERTISEMENTS, PAGE 73*



## WAR DAMAGE

The Proprietors of THE ENGINEER do not accept any responsibility for damage which may be done by enemy action to Advertisers' printing blocks, either at the offices of publication or our Printers.

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PUBLIC NOTICES

## UNIVERSITY OF LONDON

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CIVIL, MECHANICAL, ELECTRICAL and CHEMICAL ENGINEERING.

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C. H. LOBBAN, D.Sc., M. Inst. C.E.

Professor of Mechanical Engineering:—
S. J. DAVIES, D.Sc., Ph.D., Wh.Ex., M.I. Mech. E.

DEPARTMENT of ELECTRICAL ENGINEERING.

Siemens Professor of Electrical Engineering:—
J. K. CATTERSON-SMITH, M.Eng., M.I.E.E.

DEPARTMENT OF CHEMICAL ENGINEERING.
(Discontinued during the War.)

POST-GRADUATE COURSES and facilities for Research are provided in each of the above Departments, which are fully equipped with modern plant and apparatus.

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PUBLIC NOTICES

## UNIVERSITY OF BIRMINGHAM

APPOINTMENT OF GRADE II (b) LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING

Applications are Invited for the POST of GRADE II (b) LECTURER. Stipend £400 per annum. Duties to begin 1st October, 1941.

Four copies of application, together with four copies of not less than three testimonials, must be sent on or before September 6th to the undersigned, from whom further particulars may be obtained.

C. G. BURTON,
The University, Secretary.
Edmund Street,
Birmingham, 3.
August, 1941. 7680

## UNIVERSITY OF MANCHESTER

PHYSICS DEPARTMENT

Full Particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR.

The SESSION COMMENCES on THURSDAY, SEPTEMBER 25th. 7664

PUBLIC NOTICES

## HERIOT-WATT COLLEGE

EDINBURGH

The Governors Invite Applications from British subjects for the following POSTS:—

MECHANICAL ENGINEERING DEPARTMENT.—LECTURER in GENERAL ENGINEERING SUBJECTS with laboratory experience; special experience of workshop production and methods will be a recommendation.

ELECTRICAL ENGINEERING DEPARTMENT.—LECTURER with special experience in radio engineering.

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Applications must be made on forms to be obtained with full particulars from the College not later than 30th August.

J. CAMERON SMAIL,
7679 Principal.

## SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

**IMPORTANT**

**Advertisers in Situations Open Column should make themselves acquainted with the terms of**

**STATUTORY RULES & ORDERS 1940 No. 877**

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A MECHANICAL ENGINEER is REQUIRED to work under the general direction of the Superintendent Engineer in an old-established Plastics Factory. Age 30-40. Salary £650 to £750, depending on experience. Duties include the maintenance of existing plant, the erection of new plant and co-operation with the existing staff in development work. Some knowledge of Chemical Engineering advantageous. The factory is scheduled under the Essential Works Order.—Address, 7700, The Engineer Office. 7700 A

A SUPERINTENDENT ENGINEER is REQUIRED for an old-established Plastics Factory. Age 40-50. Salary £1000 to £1200, depending on experience. A man of exceptional organising ability is required. It will be his duty to co-ordinate the engineering work of the factory and promote the development of new processes. Some knowledge of Chemical Engineering advantageous. An engineer above this age limit would be considered for the war period. The factory is scheduled under the Essential Works Order.—Address, 7701, The Engineer Office. 7701 A

ESTIMATOR and RATE FIXER REQUIRED by South-West London Firm of Engineers for toolroom, jigs, fixtures and gauges and general production of aero or automobile components and assemblies. Salary up to £7 per week of 43 hours.—Apply in writing, stating if registered at any office of the Ministry of Labour and National Service, to the SUPPLEMENTARY REGISTER, 4, Gt. Marlborough Street, London, W.1, quoting order No. M787. 7706 A

GENERAL ENGINEERING WORKS, Comprising Foundries, Machine and Fitting Shops, Construction Dept., REQUIRES HEAD of PLANNING and PROGRESS DEPT. Permanent (not wartime) post with good salary and prospects. Applicants should give full particulars of age, experience and salary required.—Address, 7694, The Engineer Office. 7694 A

PROMINENT CONTRACTORS REQUIRE Capable AGENT to Take Charge of Reconstruction Work in North-West Area. Must be used control of men. Excellent prospects.—Address, 7696, The Engineer Office. 7696 A


For continuation of Small Advertisements see page 74

SITUATIONS WANTED, Page 74
AUCTIONS, Page 74
FOR SALE, Page 74
AGENCIES, Page 74
MISCELLANEOUS, Page 74
PATENTS, Page 74
MACHINERY, &c., WANTED, Page 74

*For Advertisement Rates see First Column Overleaf*


CLASSIFIED ADVERTISEMENTS CLOSE FOR
**PRESS—NOON WEDNESDAYS**

# The Engineer

## Annual Subscription Rates

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**"THE METALLURGIST."**

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next date, August 29th.

**ADVERTISEMENTS.**

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

*Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of* THE ENGINEER.

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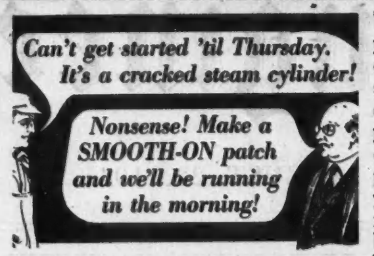
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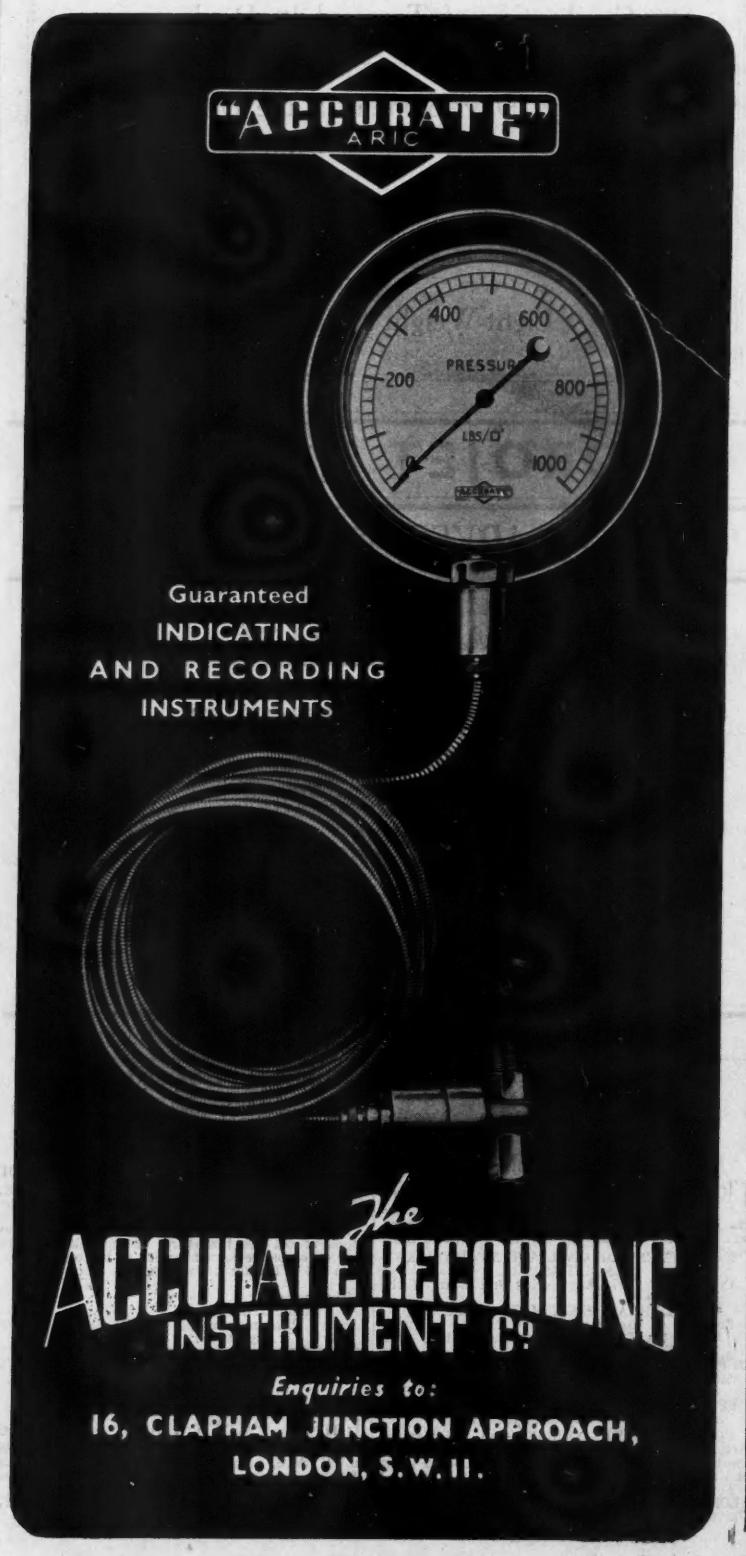


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# A Seven-Day Journal

## State Bursaries in Science

In order to meet the demands of the Services and of industry for technical officers, the Board of Education, Bournemouth, has established a scheme of State bursaries tenable at universities and at certain technical colleges by boys and girls who have reached the required educational standard. The demand is particularly pressing for men and women for radio work for which physics is essential; others will be required for posts needing qualifications in engineering and in chemistry. The bursaries will cover fees and maintenance allowances to meet the full cost of residence at the university or college at which the awards are held. They will be offered without regard to parents' circumstances. The qualifying standard will be a pass in physics, chemistry, or mathematics in certain combinations in the higher certificate examinations. The bursaries will shortly be offered by the Board to those candidates who have reached the necessary standard in the higher certificate examinations held recently. Applications are being accepted also from boys and girls who have passed the London Inter B.Sc. in the appropriate subjects. It is expected that some of the holders of State bursaries may be able to qualify for a university degree before they are required for national service; others will have to relinquish their university course at the end of a year's training.

## Deeper Loading of Ships in Wartime

The Director-General of the Ministry of War Transport announces that new Defence Regulations were made on Friday, August 15th, relating to the loading of ships. They provide that ships may load to their tropical load lines instead of their summer lines when the latter are applicable under the existing Load Line Rules, and to their tropical fresh water lines instead of their tropical lines when the latter are applicable under the existing Rules. The Regulation applies, in general terms, to all ships registered in the United Kingdom and to certain Colonial (but not Dominion) ships. The details of their application are left to be determined by orders made by the Ministry of War Transport which may impose restrictions on the application of the Regulations in certain cases. The Regulations also require the Load Line Certificates of ships to which they apply to be endorsed by one of the Load Line Assigning Authorities, and the endorsement will state clearly the limits of the deeper loading line as well as any general restrictions on the use of such deeper loading as may be laid down in the orders of the Ministry. Before endorsing a certificate the Assigning Authority must be satisfied that the ship, when deeper loaded in accordance with the Regulation, will not be an unsafe ship. In addition to the provisions requiring shipowners to apply for the Load Line Certificates of their ships to be endorsed, and otherwise for carrying the new requirements into effect, the Regulations also make provision for the international arrangements involved. For this purpose they provide machinery under which the ships of such foreign countries and British Dominions as adopt a similar scheme of deeper loading for their ships will be allowed to take advantage of such deeper loading in the ports of the United Kingdom. British ships would reciprocally be accorded similar liberty in the ports of the foreign countries or Dominions concerned. The new arrangements are to continue for not more than one year, on the expiry of which their continuance will be considered. The United States Government has already taken similar action and the support of the British Dominions, also India and Burma, may be counted upon..

## Dock Labour

A novel dock labour scheme has just been inaugurated by an Essential Work Order. It applies to London and the principal ports on the Bristol Channel, the Firth of Forth, the Humber, Tees, Tyne and Wear. The Merseyside and Clydeside ports, where the Minister of Transport is the employer, will not be affected. The scheme involves the setting up of a company to be called the National Dock Labour Corporation, Ltd., the chairman and a finance member of which will be appointed by the Minister of Labour. There will also be three representatives of employers and three of workers appointed by the National Joint Council for Dock Labour. The effect of the scheme will be to give permanent employment to dock workers. The docker will be paid the appropriate rate for his job while at work, and as soon as his job finishes he will automatically come into the employment of the Corporation and be paid 5s. for each of the eleven half-days (normally Monday to Saturday noon, inclusive) on which he reports as required but is not allocated to work. He must be prepared to take any suitable work offered. The cost of all schemes will be met from a national management fund maintained by the Corporation. Employers under approved schemes will be required to make a contribution to the fund, which will not, under present arrangements, exceed 25 per cent. of their gross wages bill. The fund will be underwritten by the Exchequer, which will, in addition, make a contribution in respect of certain administrative expenses of the Corporation.

## Tank Designer

It was announced a few days ago that Lord Beaverbrook had appointed Mr. Henry Mann Ainsworth to be Director-General of Tank Design. Mr. Ainsworth was managing director of Hotchkiss and Co. in Paris, and for that firm was responsible for over 2000 French tanks. When the Germans invaded Paris he managed to escape to America, taking with him designs of guns and tanks and up to the passing of the Lease and Lend Act was tank production expert of the British Purchasing Commission in the United States. In 1916, after holding a commission in the Army, he built and organised a factory in the Midlands, which turned out some 50,000 machine guns before the Armistice. Mr. Ainsworth arrived in this country by air a few days after his appointment. He will be responsible to Mr. Oliver Lucas, who is in charge of all the design and development work of the Ministry of Supply.

## War Damage Payments and Repairs

In one of last week's Journal notes we summarised the provisions of a new memorandum issued by the War Damage Commission, which deals with the general provisions of the War Damage Act, Part I, and the recent modifications which the Commission has made to safeguard public interest. On Tuesday, August 19th, the Commission published the first list of areas to come under the War Damage Act of the present year. They are the City and County of London, the cities of Birmingham, Bristol, Coventry, Hull, Liverpool, Plymouth, Salford and Sheffield, the county boroughs of Bootle, Birkenhead, Southampton, Swansea and Wallasey. Five other areas in England and two in Scotland are under consideration, and the names of these areas will be announced in due course. Power is given to the Commission to impose requirements as to the nature of works, the materials to be used and the time for their execution, and it may change a cost of works payment into a value or total loss payment, in those cases where the restoration of a building would be contrary to the public interest. In a statement made on Tuesday, Mr. A. M. Trustram Eve, K.C., the Chairman of the War Damage Commission, who has just returned from a tour round twenty-nine of the most badly damaged areas, said that while Wren's plan in 1666, after the fire of London, suffered from lack of finance, the Commission had been given both finance and the power to control that finance, in order to help Lord Reith's department in its modern planning. There was to be comprehensive legislation which would deal with the whole subject of planning, and the Commission would act as a stopper against individual attempts at bad planning, before the local authorities had a chance to perfect their schemes, and to carry them into operation. Thus, until more extensive powers were made available to planning authorities, the Commission could exercise considerable influence on the site and the character of any building which was to be restored or repaired.

## Dual Appointments

The report of the Committee of Public Accounts, which was published on Wednesday last, contains several passages of direct interest to engineers. Amongst them is one discussing the conditions which should attach to the "appointment to posts in Government Departments of individuals holding responsible positions in outside industry." The instructions for this practice, known officially as "dual capacity," lay down generally that the engagement of individuals, who, while holding an executive post, wish to continue participation in their private business should be avoided whenever an alternative is possible, and that, where individuals are permitted to retain active business interests, the arrangements as to the conduct of their official duties must be such as the Minister could defend to the House of Commons, the Public Accounts Committee, and the public generally. The practical working out of the system must, says the Committee, obviously depend, in the words of one witness, very largely on the discretion and honesty of the individuals concerned. It realises that these gentlemen have been specially selected for their important work and that the public are indebted to them for their services, which in a number of cases are unpaid, but they think it important that the position should be carefully watched by all concerned. Referring to the case of the staff of the Iron and Steel Control, which is paid by the British Iron and Steel Federation, and an arrangement by which the Non-Ferrous Metals Control is operated by the British Metal Corporation, which is paid a fee in respect of its staff and services rendered, the Committee recognises that it is no doubt essential for the efficient working of the control system to use the services of such associations, but at the same time "it must be realised that this system raises in an acute form the problem of dual allegiance and every care should be taken to safeguard the public interest. It may be added that the remuneration of the higher officials, indirectly paid from public funds, is likely to be greater than if they had been in the direct employment of the Ministry."

## A Scheme for Interchange of Cutting Tools

On Tuesday, August 19th, a scheme for the interchange of cutting tools was inaugurated in the Ministry of Supply Regional Area office in Birmingham by Mr. C. Maclaren, the new Regional representative, who took up his new duties on Monday, August 18th. Representatives of more than forty engineering firms in the five Midland counties attended the meeting. During the conference which followed some firms gave particulars of cutting tools which were urgently required in order to avoid critical bottle-necks in the production programme, while other firms were in a position to report that they had a stock of cutting tools in excess of their immediate requirements. It was possible to arrange more than one hundred interchanges, and this was accomplished by mutual voluntary co-operation, without the filling up of a mass of forms and without the services of officials. In the ordinary way many of the tools interchanged could not have been obtained from the manufacturers without waiting many weeks and even months. The question was raised as to whether some similar interchange system could not be voluntarily adopted to meet the case of labour difficulties. Further group meetings to extend the scheme are to be held throughout the Birmingham area. Mr. William Chance, the Chairman of the Regional Area Board, said that the willingness to help, which had been shown by all connected with the new interchange scheme, had been both marked and inspiring. He further announced that the Area Officers of the Admiralty and of the Ministry of Aircraft Production were wholeheartedly co-operating in the carrying out of the new interchange scheme.

## Machine Tool Prices

Since the beginning of the rearmament programme successive Public Accounts Committees have considered the question of securing an effective check on the reasonableness of prices paid for machine tools in the face of the refusal of the trade to accept costings, says the Committee of Public Accounts in a report just published. Some progress appeared to have been made when, on June 14th, 1939, the House of Commons was informed that the Machine Tool Trades Association had agreed on behalf of its members that a discount of 5 per cent. should be given on all standard tools for the defence programme delivered after December 5th, 1938, and that non-standard tools should be costed if the Government so desired. This arrangement was not accepted by all members of the Association, and in view of the difficulties encountered, which appear to have been due to the ill-conceived attitude of a minority of the firms engaged in the industry, alternative methods have been adopted under the Control to secure reasonable prices for machine tools. The latest scheme fixes provisional prices from July 27th, 1940, on the basis, generally, of 1935 prices plus 22½ per cent. The 1935 prices were chosen as a basis because that was a period neither of boom nor slump, when prices were competitive in a world sense. The 22½ per cent. addition took into account the increases since 1935 both in costs and turnover, and the resultant prices were expected to keep firms' total profits slightly below their Excess Profits Tax standards. These prices will be reviewed after examination, with the assistance and advice of a firm of professional accountants, of the trading accounts of suppliers and consideration of the various factors affecting costs. This scheme was accepted by the Treasury in November, 1940, on the understanding that there would be further discussion at the end of the first price period, a special report in a year's time, and investigation of costs in selected cases by the professional accountants within the initial period to test the approved prices. The Committee has received with satisfaction the assurance of the Ministry that, notwithstanding the regrettable history of this matter, the industry has been successful in effecting a remarkable expansion without, so far as the Ministry's present information goes, receiving unduly large profits. The Committee trusts that the working of the new scheme will justify the hope expressed that it provides a satisfactory solution of the difficulties previously experienced, and that the prices fixed under it will be shown to be fair and reasonable.

# The Natchez-Vidalia Bridge on the Mississippi River

No. II

(*Continued from page 101, August 15th*)

THE sub-bed of the Mississippi River is made up of strata of sand and gravel over which is laid a thick blanket of alluvial deposit. To obtain suitable support for pier footings it is therefore necessary to get down to hard pan or to the deep beds of marine clays of a remote period of deposition. The deepest pier—pier No. 2—penetrates to a depth of 155ft. below mean low water, and from top to bottom this pier has a total height of 263ft. Pier No. 1 was carried down to approximately 83ft. below ground level, and pier No. 3 has its bottom at a depth of 125ft. Pier No. 4 which is inshore, and on the Vidalia side of the river, has its bottom at a depth of 165ft. below the ground surface.

To save weight as far as practicable the piers throughout—both bases and formed shafts—are of hollow construction wherever permissible. Below river level these voids are filled with water. The base of pier No. 4 consists of two reinforced concrete cylinders, 26ft. in diameter, with walls 3ft. thick. On centres these cylinders are 44ft. apart, and they are joined at the top by means of a heavy girder or block of concrete which supports the formed surmounting shaft. The bases of the three other river piers are in general rectangular in form with their corners cut off so that the end of each pier corresponds to a half-hexagon. This shape is adopted to reduce the water turbulence which occurs with square-ended piers. The most unique feature of these piers—a complete innovation it is believed in the sinking of such deep piers—is the arrangement of design that obviated the use of removable cofferdams or other types of cofferdams in their construction. At no time was it necessary to pump out water or to unwater any parts of these piers during construction. This was achieved by extending the bases of the piers in slightly modified form to a height well above ordinary flood stages. The specifications set out methods by which the piers were to be handled and sunk with an accuracy in sinking and locating so that the tops of the piers would be in correct position for the construction of the formed shafts above the bases. Careful supervision of the construction operations secured these desired results.

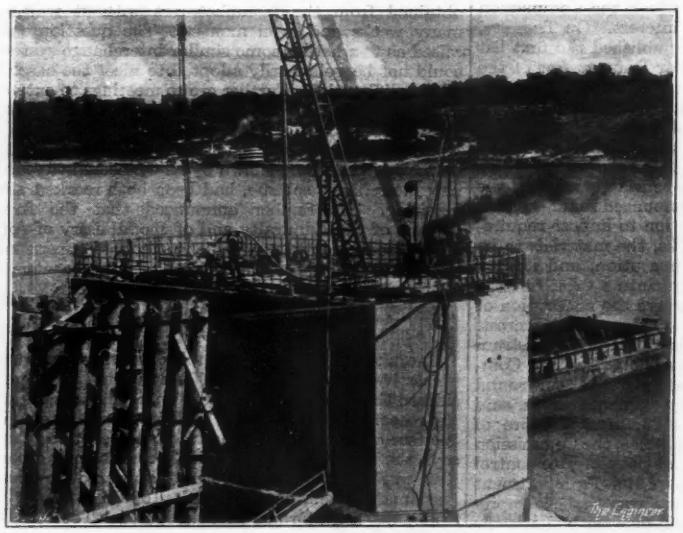
In beginning construction of open bridging piers the problem is to devise a method by which the lower portions of such piers can be built and set upon the water bed. The orignal conditions, before dredging widened the river floodway, were unusually favourable for a Mississippi River crossing. The site of pier No. 4 was then west of the old levee and in a street in Vidalia. Pier No. 1 and pier No. 3 were at the extreme sides of the original river channel where the river bed was exposed at low water so that the maximum depth of water at those piers up to the working stage of the river then contemplated did not exceed approximately 28ft. Only one pier—pier No. 2—was to be located in deep water, where the minimum depth was from 75ft. to 80ft. and the maximum depth about 110ft. at the projected working stage. For pier No. 1 and pier No. 3 the specifications provided for the use of "sand islands" to afford ground for working above ordinary river stages and made provision that work at those sites would be deferred at such stages of the river as might exceed 27ft. above low water. Of the various permissible methods applicable at the crossing, the contractor for the piers elected to adopt the sand island method. Our readers are generally familiar with the so-called sand island method of pier building and they are aware that these temporary islands require the forming of some surrounding construction, such as steel sheet piling, to retain the filling of sand, and that later, when the island has served its purpose, the retaining wall is removed and tidal or other currents are relied upon to sweep away the sand. The operations of beginning and carrying on the construction of a pier by the sand island method is as simple as kindred work on normally dry ground.

At pier No. 4 on the natural ground, and at piers Nos. 1 and 3 on the small artificial islands, the steel shoes at the bottoms of the pier walls were set in place, the forms for the concrete were erected, and the bases of the caissons built up to convenient heights. When the concrete had set sufficiently then the earth inside the wells of each caisson was excavated and the structure settled by its own weight. In this manner the sub-structures of these two piers were successively lengthened and sunk to their prescribed resting places in satisfactory foundation formations. Messrs. Ash-Howard-Needles and Tammen prepared plans for the building of pier No. 2 in deep swift-running water by a floating caisson method, which will be described a little later.

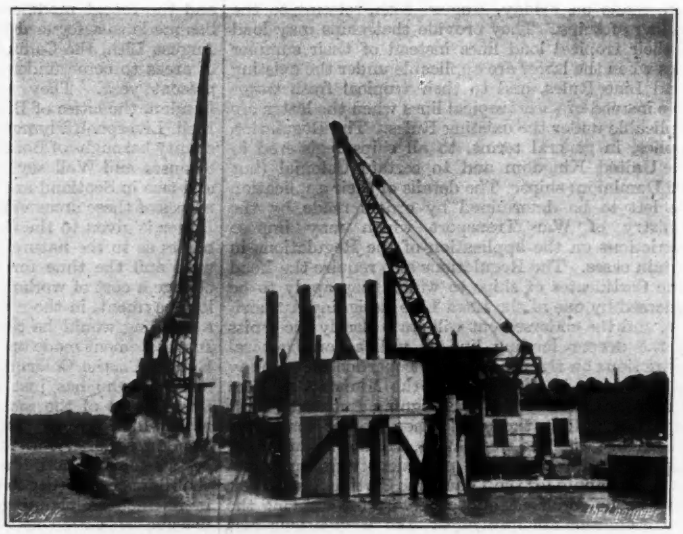
Construction operations on the several piers were, in part, carried on simultaneously, co-ordinated as conditions required, consistent with river stages; and, as concerned any individual pier, in certain respects intermittently. That is to say, when river stages prevented work at a given pier, then activities were confined to those other piers that were for the time being more favouraby situated and more readily accessible. Little need be said about the work at piers 1, 3 and 4 and 5 to 10 inclusive, since though rapidly carried out, it was done by straightforward methods. At pier No. 1 work was started on June 1st, 1939, and the pier was completed December 2nd of that year.

Work on pier No. 3, on the Louisiana shore, began January 30th, 1939, but suffered various delays from high water and otherwise, incidentally slowness of the deep shooting, and was brought to completion on January 15th, 1940. Pier No. 4, in the middle of Carter Street in Vidalia, was built expeditiously. The downstream cylinder was sunk first and to a depth of 110ft. below low water and remained at that stage until the upstream cylinder had been sunk to a total depth of 123ft. below water, where a satisfactory foundation formation was reached. The downstream cylinder was next carried to the same depth, after which the concrete sealing courses, comprising the plugs at the bottoms of the two cylinders, were placed through water-tight tremies. Regarding this work at pier No. 4, Dr. Howard states: "A very interesting condition was noted in sinking these cylinders. During the sinking of the downstream cylinder, the river was rising so that the flow of water at this pier location, well back of the levee, was upward through the sandy material, and computations indicated a maximum friction between 300 and 350 pounds p.s.f. During the sinking of the upstream cylinder, through identical materials, the river was falling and the flow of ground water was downward. Computations showed a maximum of friction under these conditions between 650 and 700 pounds p.s.f. These observations tend to support the conclusions from experiments that material called quicksand is usually that through which there is an upward flow of water, and the same material with a downward flow of ground water loses its characteristics as quicksand. It emphasises the advantage which some contractors seem loath to recognise of jets furnishing an upward rather than a downward flow of water."

Piers Nos. 5 to 10 inclusive and the west abutment—all on the Louisiana side of the river—rest upon creosoted piling, 65ft. long. The east abutment pier, on the Natchez water front, is supported by seventy-six steel H-beam piles, 12in. by 12in., weighing 53 lb. per linear foot. The average length of each of these piles was 103ft., but some of them were more than 110ft. long.



BASE SECTION OF PIER NO. 2 NEARING COMPLETION



FLOATING CAISSON AND DOCK AT PIER NO. 2

Pier No. 2, which is situated about mid-channel of the river, in water never less than 75ft. deep and exceeding 100ft. at certain working stages, was built by the floating caisson method. The lower portion of the caisson was built of steel plate walls supported on suitable steel frames, and the upper parts of plank walls were carried on steel frames. All walls were thoroughly caulked and made water-tight. The contractor built the lower section of this caisson, 64ft. long, 31ft. wide, and 20ft. high, of steel in his shops at Pittsburgh, Pa. A false wooden bottom was constructed in the caisson, and it was towed down the Ohio River to the Mississippi River and then southward to Natchez, a total distance of about 1700 miles.

For the control and management of the caisson during its sinking at the pier site, a temporary U-shaped dock was constructed with its open end downstream. The dock was patterned after a similar structure used by the consulting engineers some years before in the Willamette River, Oregon, where the minimum water depth is 90ft. For this purpose the Dravo Corporation used steel cylinders or pipes, 3ft. in diameter, and 140ft. long, which were driven in the same way as other piles and then filled with sand. The group of steel pipes or piles was joined together above water by means of a steel framework 40ft. high. The piles were braced below water with diagonal tie cables from bights around corner piles and extended from near the river bed to above water at the opposite corner. The upstream end of the dock, curved in plan, was

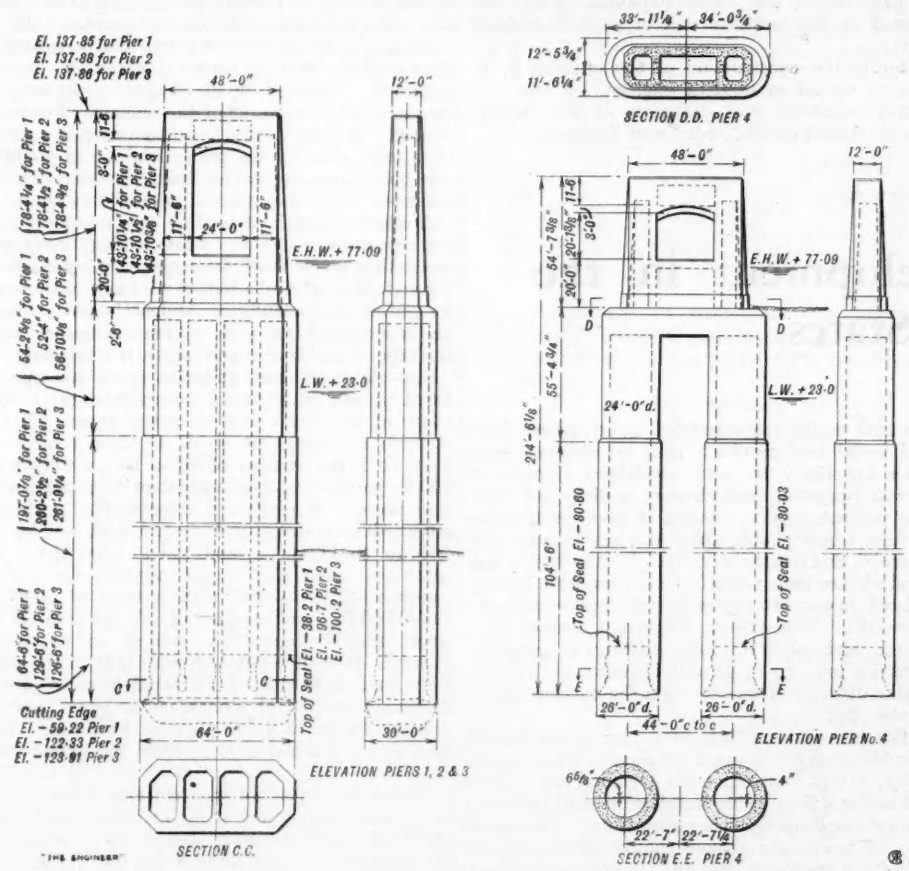
sheathed with timber piles, 130ft. long, of West Coast fir, which served to deflect the current of the river like the bluff bow of a vessel, and created almost dead water within the dock basin. The sheathing was, however, sufficiently permeable to obviate the development of upstream suction. Within this dock, the caisson was carefully adjusted to exact horizontal position, and then heavy steel guide piles were adjusted to it at several points and carefully driven in exactly vertical position. The walls of the caisson were then filled with concrete in successive lifts and simultaneously the side or form walls were built up to provide the necessary buoyancy for the increasing weight. At times the level of the concrete walls inside the caisson was more than 60ft. below the level of the river.

When the caisson reached the river bed a wooden plank and wire cable mattress, previously sunk to the bed to guard against scour, was cut through with the aid of large spuds and dredging proceeded through the dredging wells. The caisson sank rapidly, and, due to the rigidity of the dock and the guide piles, the caisson was kept accurately in position and was at no tome out of plumb. Upon reaching a foundation bed which the engineers considered satisfactory, the bottom sealing course of concrete, 20ft. thick, constituting the bottom of the pier, was deposited under water poured through tremies 10in. in diameter. Completion of the upper shaft proceeded rapidly by customary methods. Work on this pier began about July 1st, 1939, and was completed January 3rd, 1940.

The superstructure of the Natchez-Vidalia bridge was awarded the Bethlehem Steel Company about May 25th, 1939, and the order to begin work was issued six days later. The contractor began his field operations by starting the erection of falsework between the sites of piers Nos. 1 and 2 about the third week of November, 1939. Due to ice in the Ohio and Mississippi rivers, the delivery of material was delayed until February 14th, 1940, when the first of the permanent steel work was erected. From that time on until August 26th following the construction of the superstructure was carried forward with marked rapidity—only 129 days of actual erection work being required.

A pair of very substantial steel falsework bents was placed about 200ft. westward of pier No. 1 and beneath the line of span 2. A steel tower was mounted upon those bents; and, so supported, two travellers, moving away from each other, advanced east and west. A fan falsework was employed at pier No. 3, and from that point two travellers, by adopting a balancing operation, were able to move outward from that station for a distance. In order, however, to continue the erection of span 4 beyond the point of practical balancing, a total of three steel falsework bents were used with a bearing on the ground instead of on driven piles, that part of the section not being over water. Erection was continued by cantilever method throughout span 5 with a single falsework bent, before reaching pier No. 5 and continuing thence with the work of erecting the girder spans.

A start on the steel pile bents near Pier No. 1 was made about December 1st, 1939, and at that time the river was so low that its bed was dry from that point to the east abutment. The derrick boat, used to place the falsework, had a 120ft. boom supported on a tower 60ft. above the water, and at the existing stage of the river it was just able to float at the shore line and to reach over the land to drive the steel piles in the easterly bent. Forty 12in., wide-flanged, 65-lb. piles were driven to a penetration of approximately 9ft. This work was done through a steel frame which served the twofold purpose of a guide and as bracing. The frame was 12ft. by 60ft. in plan and 30ft. deep. A similar but larger frame was placed 88ft. west; it measured 25ft. by 82ft. and was 32ft. deep Through this latter frame fifty-six steel piles were driven on a batter, up and down the river, for an average penetration of 15ft. At this site there was no danger of scour because the bottom was of very hard clay, which was indicated by the penetration attained after driving to practical refusal with a No. 2 Vulcan steam hammer.

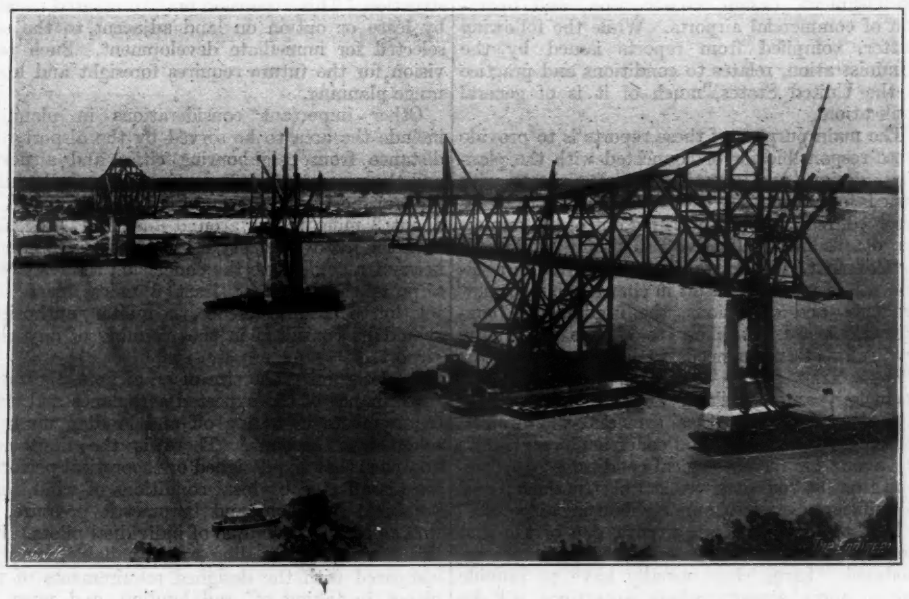



ELEVATIONS AND SECTIONS OF PIERS

Had conditions favoured, it had been planned next to erect a tower falsework on the bents with the aid of the long-boom derrick boat; but as it happened there was not sufficient water to float that craft, and it became necessary to place a temporary platform between bents on which a guy derrick could be erected that would make the necessary reaches. The derrick boat was able to get close enough to set up the platform and the guy derrick. After erecting the tower with the aid of the guy derrick and the derrick boat, then the guy derrick was jumped so that the foot of the mast was just above the floor level of the bridge. Once the guy derrick was installed at the floor level it was logical that it should be used as one of the travellers. This was accomplished, after the erection of truss steel within reach, by adding two short stiff legs, that extended from the top of the mast to the top of the chord, and resting the bottom of the mast on a travelling platform. By this expedient a guy derrick was transformed into a stiff leg derrick of a sort. Before proceeding with the main truss erection to the westward the transformed guy derrick erected a stiff leg traveller at floor level, which then took over erection work to the eastward.

These two travellers did their work while balancing about the falsework tower and continued as far as such operations were feasible. In one case this was just beyond the middle of span 2, and in the other case it extended to the east or Natchez abutment. Only one falsework bent was used, and that was at about the middle of span 1. The material for this falsework bent was obtained in part from the bent previously used near pier No. 1, after span 2 was landed on that pier. At the time the bent was placed for span 1 the river rose sufficiently so that the derrick boat could float into position to do the pile driving, although the swift current made that work somewhat difficult. In the meanwhile erection proceeded in both directions, from pier No. 2 with the aid of two guy derricks that had been converted into stiff leg travellers after the manner already described.

To start erection of the superstructure at pier No. 2 it was necessary first to make use of the derrick boat with the long boom so as to place two panels of steel on each side of the pier, with temporary ties between the mid-truss points. Even so, the derrick boat could not reach higher than the mid-height of the truss. However, with the steel thus erected, one of the guy derrick travellers was set up by the derrick boat and thereafter one jump had to be made with this guy derrick in order to reach the truss peak. Later, the second guy derrick was erected by the first guy derrick. By a similar procedure work was started at pier No. 3. The first traveller there, which operated toward the west, was a stiff leg instead of a semi-guy derrick traveller. The stiff leg traveller was able to place the second guy derrick traveller at the higher level, which was necessary to reach the peak and afterwards to set that derrick again back on



ERECTING STEELWORK: LOOKING WESTWARD FROM PIER NO. 1

the floor level, and so avoid the jumping up and down that had been needed at pier No. 2. After the semi-guy derrick traveller arrived about midway of span 3 it served as a material hoist for the stiff leg traveller that moved westward over the Louisiana shore. The closing of span 3 was purposely delayed in order that this feeding of material might be continued by picking up the steel from barges anchored directly below. As already mentioned, final closure took place near the end of July of 1940.

The peak of erection was reached during the month of May, 1940, when 2829 tons of steel was erected in the course of twenty-seven working days, an average of 104·8 tons a day. The greatest tonnage erected in any one phase of that work occurred on May 16th, when 146·4 tons was placed, On that day was scored the peak for total erection for all rigs, which amounted to 204·4 tons. Notwithstanding the rapidity with which the erecting of the steel went forward, accidents were notably few and none of the men was severely injured. That part of the crossing between piers Nos. 1 and 2 is a cantilever span that contains a true suspended span 437ft. in length. Span 3, between piers Nos. 2 and 3, is similar to span 2, except that one end of the suspended span is continuous instead of being suspended between both cantilever sections of the span. The point of suspension is nearer pier No. 3. Span 4 is similar to the span between piers Nos. 2 and 3, and the anchor arm—span 5—between piers Nos. 4 and 5 corresponds with the anchor arm between the Natchez abutment and pier No. 1. All main piers have fixed shoes. There are rocker bearings at the east abutment and at pier No. 5, and other expansion joints are located at the westerly end of each suspended span.

During the construction of the crossing I. P. Hanson served as resident engineer for the consulting engineers and designers of the bridge, Messrs. Ash-Howard-Needles and Tammen.

# Civil Airport Development in the United States

No. I

A LINE of constructive industry which is of great and increasing importance and activity in the United States is the establishment of civil and municipal airports on the ever-widening network of commercial airways. Activity in this direction has been further increased by the present movement in favour of "preparedness" for possible war, since there is the potential availability of civil airports for training and military purposes. Apart from this availability, however, this development of civil airports is independent of the vigorous activities of the Federal Government in providing adequate airport facilities for the Army and Navy.

The rapid development of civil aviation and civil aircraft within recent years was attended in its earlier stages by an enthusiastic movement for the widespread establishment of airports. Cities and towns, large and small, in all parts of the country, desired and demanded to be put on the lines of aerial transport, and also to be provided with facilities for servicing the planes, as well as for such supplementary activities as local taxi and private air travel, and the training of pilots or "airmen." As a result of this well-meant, but ill-controlled, agitation, many airports then established soon proved to be poorly situated or poorly designed, or both, so that eventually some of them were abandoned.

But that period was followed by another, in which airports became a subject for technical and critical study and design, with primary regard for air travel and airway systems as a whole. To facilitate and guide this new phase of aviation, the United States Government has created the Civil Aeronautics Administration, part of whose work has been the preparation of basic information to instruct and assist those concerned with the establishment, design, construction, and operation of commercial airports. While the following matter, compiled from reports issued by the Administration, relates to conditions and practice in the United States, much of it is of general application.

The main purpose of these reports is to provide those responsible for or connected with the planning, design, and construction of airports with basic information as to the broad general principles involved, and as to the working out of the numerous details in an effective programme of airport development. While continuing progress in aviation will of necessity result in changes to meet new problems and conditions, the fundamental considerations are not likely to change materially. Particular attention needs to be given to factors affecting the safety and efficiency of aircraft operation, among which are the following:—(1) Adequate area; (2) a firm and well-drained surface maintained in good condition at all times; (3) favourable meteorological conditions; (4) freedom from surrounding vertical obstructions; and (5) sufficient distance from neighbouring airports.

In the planning of an airport, one of the first considerations is the type of service to be accommodated. Large cities usually have to provide one or more airports whose operations will be confined mainly to scheduled air transport lines and aerial taxi service. But, in addition, such cities are likely to have specialised airports to furnish operating and storage facilities for aviation schools, sales, tourist travel, instruction service, aerial photography and surveys, dusting of crops, and other activities. In selecting a site, local surface transportation facilities must be considered, in order to ensure convenience in exchange of traffic. The extent, frequency, convenience. speed, and fares of such existing or proposed facilities may be of greater importance than the actual distance of the site from the business centre of the city.

For cities of medium size, the problems and requirements will be much the same as for the larger cities, except that one main terminal airport will suffice for a time, being supplemented by auxiliary airports or fields for other operations. For a small city or town, one airport should serve both the scheduled transport lines and the other miscellaneous or auxiliary operations. In certain cases, high cost due to topographic or other conditions may make it desirable and economical for two or more small neighbouring cities to combine their interests and finances in one common airport.

In several of the earlier projects, a combination of poor judgment, inexperience, and hasty action led to the establishment of an airport on a limited area, where expansion was made impossible by the existence of railways, paved streets, public roads, industries, or other permanent developments. Some airports of this sort had to be abandoned, as they became inadequate for increased traffic, thus involving serious loss in the investment cost. Land area sufficient for expansion must be a primary consideration in selecting a site, although only a portion of the area may be utilised in initial construction. This expansion may be assured usually by lease or option on land adjacent to the site selected for immediate development. Such provision for the future requires foresight and long-range planning.

Other important considerations in planning include the area to be served by the airport, the distance from neighbouring cities and airports, and the present and prospective lines of scheduled air transport. The desirability of a belt road of about 3 miles radius around an airport, together with the factor of safety if the airport is to handle heavy traffic, lead to the conclusion that adjacent airports should be at least 6 miles apart. In relation to national defence, the military authorities should be consulted in the planning of any civil airport.

. In determning the size of an airport, the rated performance of the expected aeroplanes and their requirements in taking off and landing must be taken into account. There is the limitation, however, that the designed or theoretical performance is affected by local conditions of wind, temperature, elevation, and barometric pressure, as well as by the technique of individual pilots. For this reason, the landing area available must be compared with the designed requirements of the planes in taking off and landing, and must be sufficiently large for the safe and efficient operation of the expected aircraft under unfavourable conditions. But here, of course, comes in the elusive factor of aeroplane development, which has already changed and complicated—or even made obsolete—earlier conceptions as to adequate size of airports. For example, there is the trend from relatively small machines with light wing loading to the large and faster transports with heavy wing loading, higher power loading, higher landing speed and slower climbing ratio.

Important factors affecting the performance of aircraft include the following:—(1) Wing loading; (2) power loading; (3) piloting technique; (4) surface friction of runway and landing areas. Of these, the first two are the most important. Wing loading is determined by dividing the permissible gross load in pounds by the total wing area. Power loading is determined by dividing the gross weight by the total horsepower of the engines. For any aircraft the wing loading, in pounds per square foot, multiplied by the power loading, in pounds per horsepower, gives an index number which indicates the performance in take-off and landing, and also the length of landing area necessary for safe operation. As the wing loading increases the stalling power increases, requiring greater speed before taking off, and a higher minimum safe speed for gliding in to a landing. And as the power loading is increased, the rate of climb decreases, and the take-off distance is consequently increased.

Aeroplanes of many different types and makes listed as now in service have an extremely wide range of the index number noted above. Those suitable for using the small or Class 1 airports have an index number of 96 to 192, a weight of 750 lb. to 4500 lb., and engines of 50 to 800 total horsepower. For Class 2 airports the machines have index numbers of 200 to 225, with weights of 2000 lb. to 14,000 lb., and 100 to 1200 H.P. In machines using the largest airports the index number is 235 to 375, with weights of 2000 lb. to 40,000 lb., and engines of 500 to 5000 H.P. Such general figures are subject to continual change. It is of interest to note that in the past few years there has been a rapid increase in the manufacture of light planes, of the types used in private flying and for trainng purposes. The production reached 3000 in 1939 and about 5000 in 1940.

Since airports are of such extreme range in size and importance, and therefore have such very different requirements in design, they cannot all be considered on the same basis, but are given a general classification, as follows:—

*Class* 1.—For communities up to 5000 population, not on air transport lines, but serving the needs of local flying and occasional itinerant aircraft. To be used by small private planes up to 4000 lb. gross weight, and with index number not exceeding 190. Landing strips, 1800ft. to 2500ft. long and 300ft. wide, with maximum gradients of 1 in 50; no runways. Site must be drained and fenced, and have markers and wind direction indicator.

*Class* 2.—For communities up to 25,000 population, and situated on present or prospective feeder-line airways. To be used by large private planes and the smaller transport planes of 4000 lb. to 15,000 lb. gross weight, and with index numbers 190 to 230. Landing strips to be 2500ft. to 3500ft. long and 500ft. wide, with runways of the same length and 150ft. wide, or 100ft. if the airport is for day operation only. Maximum gradients, 1 in 50. Besides drainage, fencing, markers, and indicators, there must be effective lighting, hangars, shop and servicing and fuelling facilities, weather information and office space.

*Class* 3.—For important cities of more than 25,000 population, and situated on feeder-line airways or intermediate points on main line airways. For use by transport planes of 10,000 lb. to 50,000 lb. weight, and index numbers over 230. Landing strips should be 3500ft. to 4500ft. long and 500ft. wide. Runways of similar length and 100ft. width if for day operation only; 150ft. for night operation, or 200ft. if for instrument operation. Maximum gradients, 1 in 66. Additional facilities would include an administration building, with tower for airport traffic control, and, when necessary, instrument approach system. The building would also provide for general offices, ticket office, waiting and baggage rooms, restaurant and lunch-room service; also news-stand and such other concessions as might be desirable. There would also be provision for the guidance, information, protection, and control of passengers in embarking and disembarking.

*Class* 4.—For major industrial centres and

important junction points or terminals on main airway systems. For use by the largest planes in service and in prospect for the immediate future, with gross weights of 50,000 lb. or more, and with a load index of 230 and over. Landing strips at least 4500ft. long and 500ft. wide. Runways and miscellaneous facilities to be the same as for Class 3. Parallel runways may expedite the taking off and landing of aircraft. Maximum gradients, 1 in 66.

Landing strips and runways must be in sufficient number to permit take off and landing within 22½ deg. of the true wind direction, with winds of 4 miles per hour or more. Winds of 3 miles per hour and less are negligible. Longitudinal intersecting gradients on a runway or landing strip should be joined by a vertical curve at least 500ft. long. Tangents or straight stretches between horizontal curves should be at least 1000ft. long. In general, landing areas should have no change in gradients of more than 0·5 per cent. in any 100ft. interval.

For regular or scheduled operation, the minimum recommended length of landing strip is 3000ft. for small transport planes and 3500ft. for others. Approaches should be clear of vertical obstructions within a glide path of 20 to 1 from the ends of runways for small airports of Class 1 and 30 to 1 for the other three classes. For instrument landing runways, however, the ratio should be 40 to 1, measured from a point 4500ft. from the beginning of the runway. The approach or approach zone is a trapezoidal area having a width of 1000ft. at the boundary of the airport or landing field, and broadening to a width of 4000ft. at a distance of 2 miles from the boundary, its centre line being a continuation of that of the landing strip.

The figures given above as to the length of landing areas are for sea-level situations. For higher elevations increased area must be provided for the take-off run and the landing run, since aeroplanes land and take off at higher speeds and climb at flatter angles as the altitude increases. This results from the normal decrease in atmospheric density and the consequent decrease in the lifting effect of the air on the wings, while in certain types of motors it results also in a decrease of horse-power delivered. The lengths of runways and landing strips at high altitudes would be as given in Table I. The effect of altitude is less marked in the large airports of Class 4, since it is assumed that aeroplanes which determine the size of such airports would be equipped with supercharged engines.

TABLE I.—*Length of Runways*

| Elevation above sea level, feet. | Length of runway, in feet. | | | |
|---|---|---|---|---|
| | Class 1. | Class 2. | Class 3. | Class 4. |
| 2,000 ... ... ... ... | 2,040 | 2,840 | 3,980 | 4,860 |
| 4,000 ... ... ... ... | 2,340 | 3,250 | 4,550 | 5,250 |
| 6,000 ... ... ... ... | 2,690 | 3,740 | 5,230 | 5,670 |
| 8,000 ... ... ... ... | 3,120 | 4,350 | 6,070 | 6,150 |
| 10,000 ... ... ... ... | 3,660 | 5,090 | 7,120 | 7,120 |

*(To be continued)*

# Air Force Targets in Germany

No. XXII

*(Continued from page 387, June 13th)*

### RHINELAND POWER STATIONS

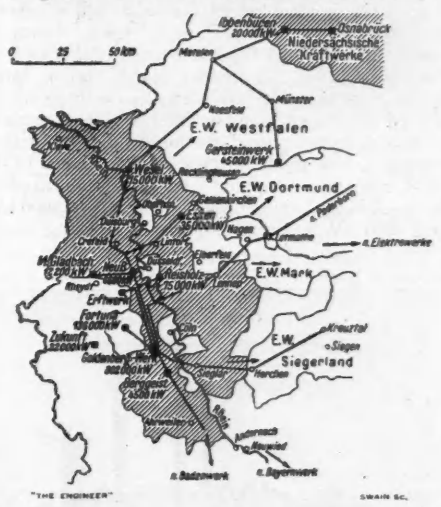
AS we recorded in one of our last week's Journal notes, the Royal Air Force carried out on Tuesday, August 12th, an important and intensive daylight air attack on large electric power stations in the Rhineland, not far from the city of Cologne. Earlier in that week, and also during the present week, aircraft of the Bomber Command have made night attacks on Krefeld, Rheydt, München-Gladbach, Düsseldorf and other important power station and supply areas in Western Germany. The attacks made on the Goldenberg power station near to Knapsack, and the two Fortuna No. I and No. II stations near to Quadrath, are outstanding in view of the large scale of the raids and the damage done. It is recorded that six squadrons of Blenheim bombers belonging to the Bomber Command took part in the operations and that they were accompanied by fighters in strong force as far as Antwerp, the fighters meeting the returning bombers at the same point. For Tuesday's day operations a total loss of twelve Blenheim bombers and eight fighters has been recorded. In view of these successful operations some particulars of the generation and distribution of electricity supply in the Rhine area may be of interest to our readers.

### RHEINISCH-WESTFALISCHES ELEKTRICITATSWERK A.G.

The most prominent of the electricity undertakings in Western Germany is undoubtedly the Rheinisch-Westfälisches Elektricitätswerk A.G., known as the R.W.E. It had its beginning with the building of the Essen power station about 1898, and it has now grown to be one of the most important undertakings of its kind in Central Europe, controlling not only the generation and distribution of electric light and power, but the production of gas for heating and lighting, and its distribution by means of an extensive gas grid. The accompanying engraving shows the extent of the R.W.E. supply area, which is bounded by the Netherlands frontier to the north and the Ahr in the south, with Holland and Luxemburg to the west, and the Hanover district to the east. There are interconnecting lines with water power stations on the Luxemburg frontier, while to the east is the Elektrowerk network. The R.W.E. power stations include those at Essen, Wesel, Düsseldorf-Reisholz, München-Gladbach, also the Eftwerk and the group of large power stations in the lignite area near to Cologne, namely, Fortuna I and Fortuna II, Zukunft and Goldenberg. It is with the three largest stations in the lignite fuel group that we are more concerned, as these were the direct object of Tuesday's daylight raids.

### THE FORTUNA POWER STATIONS

The company for the development of the lignite deposits was the Rheinische Aktiengesellschaft für Braunkohlenbergbau und Brikett Fabrikation, of Cologne, which was originally founded in 1898 under the name of Fortuna and became a public company in 1902. It owns nine lignite mines and one central repair shop. We reproduce a view of one of the mines in the accompanying engraving, which also shows the two power stations, Fortuna I and Fortuna II, on the edge of the excavation. Lignite is mined by surface digging and the excavation, mining, briquette production and loading are all mechanised as far as possible, rope-driven bucket conveyors and also long-distance conveyors with large self-discharging trucks being employed. The briquetting presses are of the single and double patterns, and there are plants for the preparation of the crude lignite. This raw fuel contains about 60 per cent. of water and its maximum heating capacity is 1800 to 2000 kilocalories per kilogram, the ash and sulphur content being quite low. After drying and briquetting, the water content is reduced to 12 to 15 per cent. and the heating capacity is increased to 4800 kilocalories per kilogram. The raw lignite as it comes from the mine is dumped

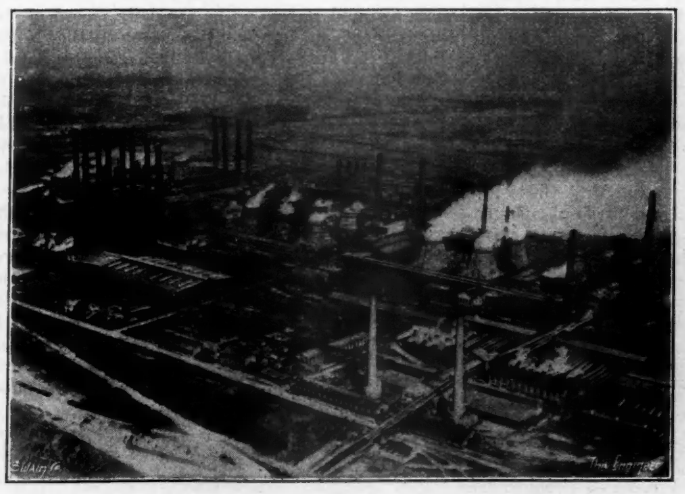



MAP OF R.W.E. HIGH-TENSION NETWORK, 1928

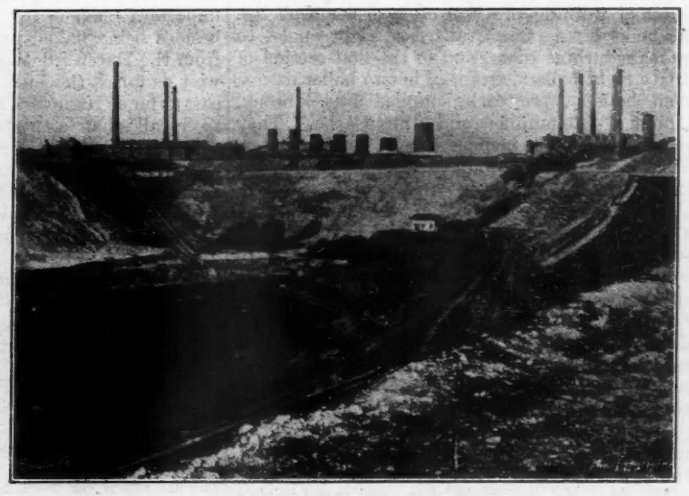
from trucks into hoppers, from which it is conveyed to the crushing house, where it is broken up and screened. The "oversize" reject passes directly to the boiler-houses of the two Fortuna power stations, or it is loaded into wagons for delivery by train as raw fuel. About 25 per cent. of the lignite thus mined is utilised in its raw state for the production of electric power, and about two-thirds of that amount is burnt under the boilers of the Fortuna power stations on the site of the mine and its briquetting plant, and in the neighbouring large power stations of Goldenberg, near Knapsack, and the Zukunft power station belonging to the Kraftwerk Braunkohlenindustrie A.G., which has a capacity of about 50,000 kW, and in conjunction with the water power stations in the Ruhr area, serves the towns of Aachen, Eschweiler and Stolberg and also eight country districts and about ten large industrial works.

The lignite which is not used for boiler fuel is further crushed and dried in rotary kilns after which it is cooled and delivered to the press houses, where the briquettes are produced, which are sold in Cologne and other Rhineland towns.

After considerable experimental work, part of



GOLDENBERG POWER STATION NEAR KNAPSACK



FORTUNA LIGNITE MINE WITH POWER STATIONS NEAR QUADRATH

which was carried out as early as 1908 in Dalmatia and in the Lackawana Steel Company's works at Buffalo in America, the power station Fortuna I was planned for burning lignite fuel and was one of the first of its kind. It was built about 1911, power being supplied to the city of Cologne in the July of that year. The first turbine installation had a designed output of 8000 kW, but by the end of the last war the station capacity had risen to 40,000 kW, most of the turbo-alternator units being of moderate output. It is of interest to record that the planning of Fortuna I was entrusted to the late Professor George Klingenberg, and the turbo-alternators were supplied by the Allgemeine Elektricitäts Gesellschaft, of Berlin. The size of the power station has been increased step by step and records show that by 1928–1929 its capacity had risen to 72,000 kW, the various units then embracing sets from 8000 kW up to 20,000 kW, running at speeds of 1000 to 3000 r.p.m. The boilers were, of course, specially adapted for the burning of lignite fuel, and a feature of the original design was the provision of five tall chimney stacks, rising to a height of about 116 m. above the site. The power station is clearly shown in outline in the top left-hand corner of the view of the lignite mine. A further feature is the large Balcke type counter-current cooling towers, which figured prominently in the published photographs of the Cologne power station raid. A further extension was made to this station about 1937–1938, when two "topping" turbines were supplied by the A.E.G., having designed outputs of 8600 kW and 9800 kW respectively, with a working steam pressure of 65 to 80 atmospheres and a final superheated steam temperature of 510 deg. Cent., exhausting to the other turbines at a back pressure of 15 atmospheres. For these two turbines new special high-pressure boilers were installed. The need for a second power station was felt shortly after the end of the last war, but lack of materials delayed the project until about 1920, when the design was entrusted to the Siemens Schuckertwerke G.m.b.H., of Berlin. The preliminary plans were made for a station of about 30,000 kW output, but while the work was in progress the capacity was increased to 50,000. Further extensions have been made from time to time, and published records show that in the year 1934–1935 current to the extent of 510 million kilowatt-hours per year was being bought from Fortuna II by the R.W.E. Most of the original turbo-alternator sets were made by Siemens-Schuckert and each has a capacity of 16,100 kW, steam being supplied to the turbines at a pressure of 14 atmospheres and at a temperature of 350 deg. Cent. The boilers are designed for a normal working pressure of 15·5 atmospheres. The boiler-houses are arranged at right angles to the main turbine room, and in the first section of twenty-eight boilers, arranged in two boiler rooms, seven boilers were each supplied by Babcock, Hanomag, Steinmüller and Dürr-Garbe. They are in general of the inclined tube or vertical water-tube types and are equipped with chain-grate or alternatively hopper firing.

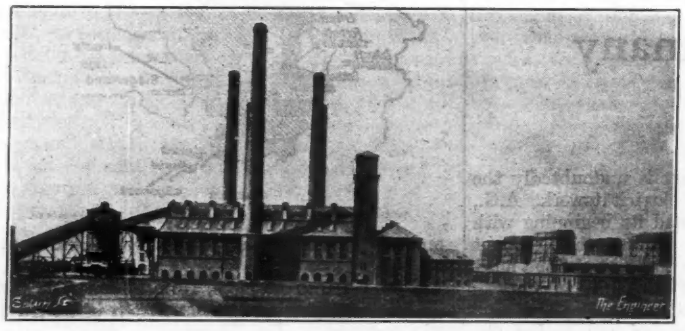
The main buildings, some of which can be seen in our illustrations, comprise a fuel breaker house and distributing tower, two boiler-houses with five tall chimneys, with additional buildings for ash handling, switch house, turbine room, water and water softening plants, cooling towers, and administration buildings. In the final design room was left for doubling the size of the station, with finally five boiler rooms, ten chimneys and ten cooling towers instead of five. The cooling towers are of the standard Balcke design and are built to deal with 6000 cubic metres of water per hour, cooling it through about 10 deg. Cent. They have twelve sides and are made of treated wood with a steel frame.

One of the latest turbo-alternator sets to be installed in Fortuna II was a 21,000-kW A.E.G. unit, designed to work at a pressure of 100 atmospheres and to exhaust at 3·7 atmospheres. For this high working pressure special boilers were designed and built, lignite fuel firing being retained.

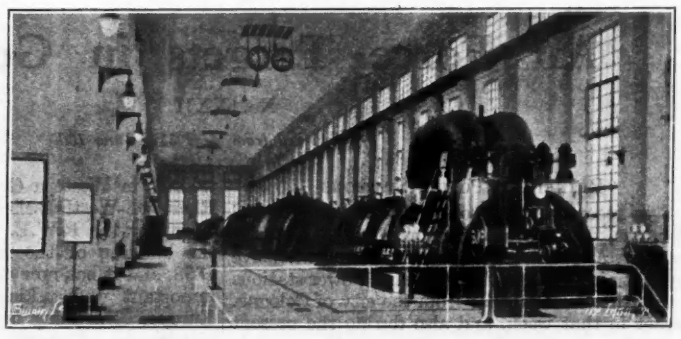
### Goldenberg Power Station

In the accompanying engraving we reproduce a general view of the Goldenberg power station of the Rheinisch-Westfälisches Elektricitätswerk A.G. It was built prior to the last war, the preliminary design being already prepared in 1912. During the early part of 1914 the first four turbo-alternators were put to work. They consisted of four 1500-kW sets, two of which were supplied by the A.E.G. and two by Siemens-Schuckert. The site chosen for the works is at Knapsack, not far distant from Cologne, but close to the lignite deposits previously referred to. The power station was designed by Director Goldenberg, who at that time was the leading figure in the R.W.E., and it was later called the Goldenbergwerk, thus taking the name of its designer.

During 1917 and 1918 the A.E.G. delivered two further 14,000-kW sets and from 1919 to 1925 there followed four 42,000-kW turbo-alternator sets running at 1500 r.p.m., which at the time were looked upon as among the largest machines of the kind built up to that time. About this date the boiler capacity of the station comprised sixty-eight vertical water-tube boilers, designed to burn lignite fuel and to produce steam at 15·5 atmospheres pressure with a high degree of superheat.



View of Fortuna II Power Station



View in Turbine Room of Fortuna II

The Goldenberg power station was one of the first to be designed for 100,000-volt transmission, and the network of outgoing high-tension lines can be seen clearly in our engraving. In common with the Fortuna power stations already referred to, Goldenberg is noteworthy for the large number of Balcke cooling towers. Further additions to the station were made in 1929, when two sets, each of 53,000 kW capacity, both of A.E.G. design, were added, while later additions have included a 30,000-kW Ljungström turbine, probably of M.A.N. construction, with possibly other large Siemens-Schuckert sets. The capacity of Goldenberg has steadily grown and from small beginnings in in 1914 it reached 290,000 kW in 1929, 400,000 kW in 1926, and for 1933 a figure of 500,000 kW output is recorded. Its capacity before the recent air attack may have exceeded the 500,000-kW figure.

Enough has been said to indicate the importance of these three power stations in Germany's war effort, supplying, as they do, many of the principal towns in the Cologne area, with their equally important engineering and chemical industries, besides being linked to a network which extends from the Dutch frontier down into Austria, to the west as far as the Luxemburg borders, and to the east as far as Hanover. In conclusion it is of interest to recall that a well-known authority on the design of power stations, writing in 1939, defended the German practice of including high brick or concrete chimneys, on the ground that these tall vertical surfaces in the design of a power plant must inevitably protect a power station from attacking aircraft, and were thus to be preferred to the low steel smokestacks which are sometimes adopted. Whatever the protective value of tall chimneys may be, it is equally certain that they provide an excellent means of identifying a particular plant.

**Power from Sugar.**—The Australian Government has suggested to the sugar industry the desirability of making increased supplies and utilising them for the production of power alcohol, thus using the portion of the annual sugar surplus which can no longer be exported owing to the shortage of shipping. It has been estimated that four million gallons of power alcohol could be produced annually.

## Letters to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### MONKLAND AND KIRKINTILLOCH RAILWAY

Sir,—I have read Mr. Dendy Marshall's letter in your issue of June 20th last, in which he refers to the above-named railway. The document he quotes from was first known to me through a correspondent of the *Locomotive Magazine*, whose letter appeared some time in the late 'twenties. Mr. E. L. Ahrons drew my attention to this, but our further joint investigations failed to substantiate the claim of George Dodd or Dodds (he is described as Dodd in some accounts, not Dodds). He may have supervised the assembly of the engines in Glasgow and possibly have introduced some modifications, but there is then to explain the claim of Isaac Dodds that he furnished the design of a Killingworth engine with special features for the Monkland line in the year 1830.

This claim is supported by Zerah Colburn in his memorable work "Locomotive Engineering," 1871.

George Dodd or Dodds was not related to Isaac Dodds, and from the little that is known of his career was certainly not qualified to design a steam locomotive.

A former member of the chief engineer's staff, Caledonian Railway, investigated Isaac Dodds' personal notes as to his experiences with Scottish lines as far back as 1913, at my request. Not only as to the Monkland Railway, but in connection with the Carlisle-Glasgow section referred to in my book, "A Story of Railway Pioneers." This gentleman, who joined the Caledonian Railway, as it would be at that time, about the year 1850, advised me that from all the information he had been able to gather the builders of these two Killingworth engines of the Monkland Railway "drew on Tyneside for the necessary resources and skill in undertaking such novel work."

The notes left by Isaac Dodds as to his activities at his engineering shops, Felling-on-Tyne, state "machined parts" supplied for the Monkland engines. This in addition to provision of the design.

There I must leave this question. But I should like to add in view of the criticisms my book received, I have followed up with many articles not only proving beyond doubt many of the claims of Isaac Dodds, but have brought out much additional information as to his contributions to locomotive and general railway work.

A most valuable diary came into my hands many years ago and proved to be the daily record of the secretary of an important section of the North Midland Railway. The diarist had made his entries in an old form of cipher interspersed with scraps of Latin, and had evidently intended that no one should transcribe. By searching through innumerable records of old codes and ciphers I found that he had used the system of Jeremiah Rich, a priest of the seventeenth century.

The story told of day-to-day activity from 1836 to 1842, in the office of a railway company, beginning with the purchase of the first office desk and finishing with the business difficulties, which brought the company to seek amalgamation with stronger lines.

Extracts from the diary are given in my article published in the *Railway Magazine* of November, 1938. In this, for instance, I give details of the first turntable ever made to work on "a smooth outer ring."

Some correspondents have queried the existence of Isaac Dodds' "Cutler" locomotive of 1836. This engine was the first to be fitted with a self-acting reversing and expansion gear and other innovations which are now standard practice. Contemporary

accounts did not satisfy them. Only reference to a coroner's inquest describing how the "Cutler" engine, in use as a contractor's engine, ran over and killed a navvy workman during the month of February, 1837, obtained complete appeasement!

August 9th. S. SNELL, Major.

"THE WORLD WE HOPE TO LIVE IN"

SIR,—I have read with interest the correspondence on this subject, and venture to offer a comment on Professor Soddy's letter in your issue of August 1st.

I do not think Mr. J. E. Tuke necessarily overlooked the *rôle* of money in the solution of the problem of securing a free flow of goods from producer to consumer. Surely it was implicit in his letter that the object of production was use and consumption. It is true that the mass of the people have not so far troubled to specify their one combined objective as both producers and consumers. I think that if they considered the matter they would agree that it was to live and let live in peace with plenty and security. If and when they formulate this objective, translate it into an expression of their will, and enforce their will democratically through Parliament, it will probably be found necessary for the Government to license financiers in order to control them should they fail to make the money system function so as to achieve the specified end. Perhaps the shocks of war may precipitate the formulation of the people's will and so make democracy a living reality.

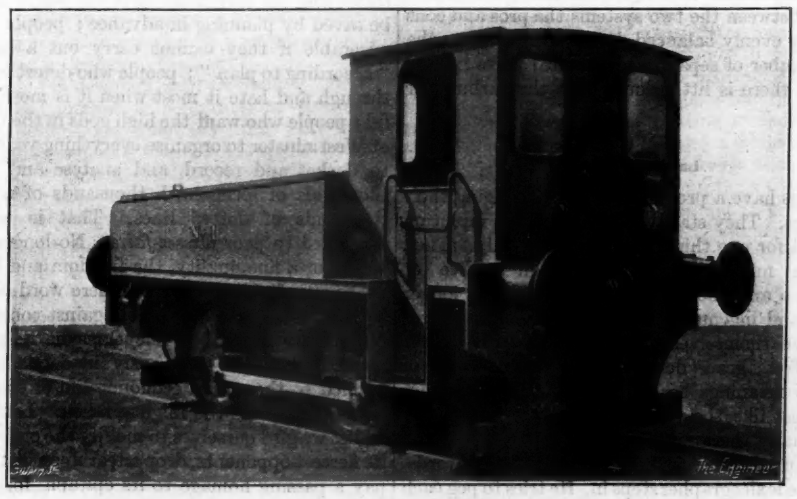
Oxted, August 15th. W. A. WILLOX.

## Battery Locomotive for Industrial Haulage

THE battery locomotive illustrated herewith has recently been supplied by the British Thomson-Houston Company and put into regular industrial service. It is taking the place of an oil-engined locomotive previously employed, in a temporary capacity, for the performance of similar duties. The immediate availability for service calls, the silence of operation and the complete absence of all stand-by losses are claimed to be advantages in its favour.

The locomotive weighs 10½ tons and is driven by a single traction motor geared to one of the two coupled driving axles. The length of the wheel base is 5ft. 3in. and the gauge of the track is 4ft. 8½in. The negotiation of curves is therefore a simple matter. The single motor is provided with roller bearings for the armature, and a common oil well feeds both suspension bearings, thus reducing lubricating maintenance to the minimum. The axle-box oil wells and the side rod bushes are accessible from outside the locomotive. The traction motor is rated at 20 H.P. on 150–200 volts, and is operated from a 380 ampere-hour Nife battery of 124 cells, controlled by means of a drum type tramway controller of standard design modified for single-motor operation. The spare contacts on the reversing cylinder of the controller are utilised to effect the change over in the head and tail lighting, in accordance with the position of the reversing handle and, consequently, the direction of travel of the locomotive. The battery is charged from a rectifier sub-station adjacent to the running shed and a boost is given to the battery during the midday dinner interval.

The remaining electrical equipment follows the usual lines and includes two circuit breakers, a meter of the Sangamo type, a charge and discharge ammeter, a voltmeter and the necessary lighting switches. The accelerating and braking resistances are of edgwise wound strip construction and are specially designed for the arduous duties associated with industrial haulage. The locomotive is provided with rheostatic braking and hand brakes on all wheels, and is capable of hauling some 75 tons on the level. Although it is not permissible to mention the nature of the duties regularly performed by this locomotive, it may be said that the absence of fumes, grit or sparks makes it particularly suitable for the work to be done.



ELECTRIC BATTERY LOCOMOTIVE

## Sixty Years Ago

STEEL *versus* IRON SHIPS

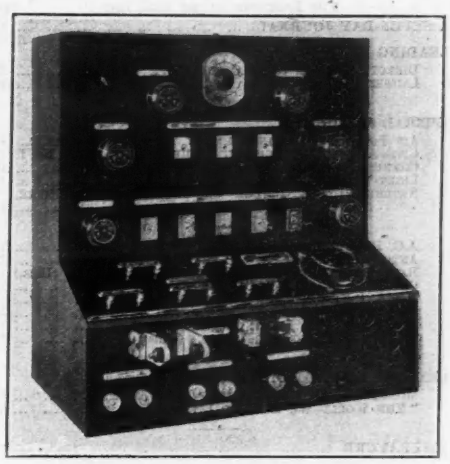
AT the Newcastle summer meeting of the Institution of Mechanical Engineers, held in August, 1881, Mr. John Price, general manager of Palmer's Shipbuilding Company, presented a paper "On Iron and Steel as Constructive Materials for Ships." The object of the paper was to debate the question whether it was more economical, for commercial purposes, to build vessels of steel rather than iron. Mr. Price's conclusions were that under the circumstances then prevailing and in his own district, cargo carriers could be built more cheaply in iron than in steel, that goods could be conveyed by sea more cheaply in them and that they were a better investment for shipowners. For some reason which is not quite clear Mr. Price's paper excited considerable ill-feeling. Mr. Daniel Adamson, of Manchester, maintained that the subject was merely a commercial matter and was unworthy of the attention of the meeting. Mr. Denny, of Dumbarton, challenged the accuracy of some of Mr. Price's figures, whereupon there ensued between them "a very unpleasant personal discussion," which, as we expressed it in our report of the proceedings, was to be regretted in every way and which was best forgotten. After the heat of the fray had died down we discussed Mr. Price's thesis in a leading article in our issue of August 19th, 1881. After examining the question at issue in its various bearings, we felt, we said, inclined to believe that Mr. Price's conclusions were substantially right and that the hue and cry directed against them was substantially wrong. We expressed the opinion that iron as a shipbuilding material would be found very difficult to supersede, firstly, because it answered the purpose for which it was used very well, and secondly, because it was at least £3 per ton cheaper than the mild steel advocated as a substitute for it. At the most steel would enable a ship to be built with 10 per cent. less weight than an iron ship of the same type and size. In some trades, such as the Spanish ore trade, the reduced weight might be reflected in increased loadings, but in many others, such as the tea trade, the loading was determined by the cubic capacity of the holds and would not be affected by the reduced weight of the ship's structure.

## A.C. Instrument Test Panel

WE illustrate herewith a new A.C. voltmeter and ammeter test panel which has recently been developed by Salford Electrical Instruments, Ltd., for general laboratory use. This panel is intended to supply current and voltage for the calibration of voltmeters and ammeters and is entirely self-contained. It comprises a number of transformers, the primaries of which are supplied from a continuously variable transformer which in turn is fed from a variable-tapped choke connected to the A.C. mains. Six miniature circuit breakers are provided as overload protection for the various circuits and before any circuit may be used no less than three switches have to be closed, so that the possibility of making an error which would damage the equipment is remote.

The maximum output provided ranges in ten steps from 50 mA at 600 volts to 1000 mA at 2 volts. By setting the load factor switch shown in the centre of the panel near the top the maximum voltage output on each range may be reduced to 75 per cent., 50 per cent., 25 per cent. or 10 per cent. of these figures. The maximum volt-ampere burden varies from 30 VA on the first range to 2000 VA on the tenth. Continuous stepless variation from zero to maximum is provided on every range.

All the transformers are run at a very low flux density, thus ensuring that the output is free from wave form distortion. The standard panel is for use on A.C. only, 230 volts, 50 cycles, but may be supplied for other mains voltages or with different ranges if desired.



VOLTMETER AND AMMETER TEST PANEL

## ANTONIO PACINOTTI

THIS year occurs the centenary of the birth of Antonio Pacinotti, pioneer of the dynamo. Born at Pisa, June 17th, 1841, he was the son of Luigi Pacinotti, Professor of Physics at the University there. His greatest contribution to electro-technics—the ring armature—was invented by him at the age of nineteen. Dr. Werner von Siemens in 1855 had invented the shuttle armature consisting of a cylinder of iron with two longitudinal grooves in which a coil of insulated wire was wound; the ends of the wire were attached to commutator segments. In the ring armature an endless spiral of insulated wire is wound on an iron ring and is divided into equal sections, connected to the commutator, thereby obtaining a steadier current than with the shuttle armature. It is clear from Pacinotti's description in *Il Nuovo Cimento*, 1865, that he intended it for use as a motor, although aware that it could be used as a generator, for which purpose the field magnets were to be excited with current from a voltaic battery. Pacinotti was of a studious, retiring disposition, and allowed his armature to be taken up by others, notably Z. T. Gramme, of Paris, who exploited it and is frequently believed to be its inventor, indeed, his name is given to it. Pacinotti latterly was appointed to the Chair that had been occupied by his father in Pisa, and died there May 24th, 1912.—*Newcomen Quarterly Bulletin*, July, 1941.

COLONEL GEORGE CLOWES.—It is with deep regret that we have to record the sudden death, on August 16th, of Colonel George Clowes, chairman and managing director of William Clowes and Sons, Ltd. For several months, whilst THE ENGINEER was being printed in his company's works at Beccles, our associations with Colonel Clowes were of the most friendly, and leave us with the kindest memories of a man as upright in his business as he was active and progressive. His death is not only a severe loss to his own company, but to the printing industry of Great Britain.

L.N.E.R. CHIEF ELECTRICAL ENGINEER'S DEPARTMENT.—The L.N.E.R. announces that the following changes of title in the Chief Electrical Engineer's Department have been made:—Mr. H. H. Swift, Assistant Electrical Engineer, to be styled Assistant Chief Electrical Engineer; Mr. B. James, Assistant Electrical Engineer (Southern Area), to be styled Electrical Engineer (Southern Area); Mr. H. W. Green, Assistant Electrical Engineer (North-Eastern Area), to be styled Electrical Engineer (North-Eastern Area); Mr. J. R. Shewan, Assistant Electrical Engineer (Scottish Area), to be styled Electrical Engineer (Scottish Area).

MEMORIAL TO LORD AUSTIN.—Lord Nuffield has inaugurated with a personal contribution of £1000 a fund for a memorial to the late Lord Austin. A similar sum has been promised by the Austin Motor Company, Ltd. Lord Nuffield feels that, in view of Lord Austin's outstanding services to the cause of motoring and his brilliant achievements as an engineer, it would be a grave omission if a prominent and lasting memorial to him were not brought into being. While the ultimate form must depend to some extent on the amount subscribed, it is hoped that the bulk of the money will be allocated to an endowment fund to be administered by the Motor and Cycle Trades Benevolent Fund.

# The Engineer

*AUGUST 22, 1941*

VOL. CLXXII No. 4467


## Contents


THE ENGINEER, August 22nd, 1941 PAGE

A SEVEN-DAY JOURNAL ... 113

LEADING ARTICLES—
DIRECT INJECTION *versus* CARBURETTER ... 120
LAISSEZ-FAIRE ... 120

SPECIAL ARTICLES—
AIR FORCE TARGETS IN GERMANY. No. XXII. (Illus.) ... 117
CIVIL AIRPORT DEVELOPMENT IN THE UNITED STATES No. I. 116
COMBUSTION OF TAR AND ITS PRODUCTS. (Illus.) ... 122
LIGHT-WEIGHT STEAM PLANT ... 121
NATCHEZ-VIDALIA BRIDGE ON THE MISSISSIPPI RIVER. No. II. (Illus.) ... 114

A.C. INSTRUMENT TEST PANEL. (Illus.) ... 119
ANTONIO PACINOTTI ... 119
BATTERY LOCOMOTIVE FOR INDUSTRIAL HAULAGE. (Illus.) 119
CHROMIUM PLATING OF CYLINDERS ... 123
H.M.S. "KING GEORGE V." (Illus.) ... 122
METAL-COATED PLASTICS ... 125
MOTOR-CARS AND LIGHTNING ... 125
REINFORCED CONCRETE BARGES. (Illus.) ... 124

LETTERS TO THE EDITOR—
MONKLAND AND KIRKINTILLOCH RAILWAY ... 118
"THE WORLD WE HOPE TO LIVE IN" ... 119

LITERATURE ... 121

NEWS AND NOTES—
FORTHCOMING ENGAGEMENTS ... 126
MARKETS, NOTES AND NEWS ... 125
NOTES AND MEMORANDA ... 126
SIXTY YEARS AGO ... 119



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## DIRECT INJECTION *versus* CARBURETTER

WITH the direct injection of fuel into the cylinders of C.I. engines we have for long been familiar, and even more intimate with the carburetter system of our own motor-cars. When the day came for aircraft to be engined it was natural for the automobile type to be chosen. Its speed of rotation was about as high as that required by the airscrew of the day, and now only requires a modest amount of gearing, whilst its power output for a given weight was much better than that of any other form of prime mover. In the interval between the two great wars an energetic attempt was made—notably in America—to add to the merits undeniably possessed by the aero-engine so developed, some at any rate of the advantages possessed, or believed to be possessed, by the direct injection type.

The inventors of the modifications having this step in view considered no doubt all varieties and combinations possible. One of the most attractive proved to be the replacement of the familiar carburetter system by as many petrol pumps as there were cylinders. These worked on what was called the "solid injection" system, as distinct from the air pressure method of the genuine Diesels. In this way one could make sure that an allotment of fuel really did enter each cylinder to mix with the air waiting for it; the difficulty then, as it is still, was to ensure that a precisely equal supply should reach each cylinder in turn. By adopting this procedure the air and fuel did not meet until both were inside the cylinder; but it was equally possible to design an injection system in which the fuel and air mingled at an earlier stage and it is in this form that injection systems are much in vogue to-day both in America and elsewhere. New developments on these lines, as on most others that bear at all on the war, are not now broadcast, but what the German Air Force has done and is doing in this direction we do know, since all captured machines are carefully examined by our own experts. The method preferred by the Germans is to inject the fuel directly into the cylinders; since they need not have faced the many mechanical difficulties this entails, they must have had, or thought they had, good reasons for preferring this system to the obvious alternatives of injecting the fuel into the air on the entry side of the supercharger, or immediately afterwards, though still before reaching the cylinder interior. What those reasons were we can only surmise, but it is of value to consider what is gained or lost by adopting one or other of the several possible combinations. Perhaps the most attractive feature of injection systems is the freedom it gives from refrigeration icing. The routine throttling common to carburetters involves a lowering of temperature—as in an ordinary refrigerator—and this may lead to ice formation, especially at the throttle. If it does the engine will be slowed up at once. Such an ill is successfully avoided in British engines by heating the carburetter body, so giving as good freedom from icing as the injection method can give. Another seeming advantage possessed by the injection system is its ability to deal with those lower grades of petrol which will not vaporise sufficiently readily to be suitable for use in a carburetter. But how much use would such a fuel be when it reached the cylinder? It requires a high-grade fuel to operate without detonation at the high compression ratios of to-day, and these are easily dealt with by the carburetter system. A claim is made for the injection system that it can give better equality of distribution between the cylinders. This might be true of direct injection into the cylinders themselves provided, and it is a vital proviso, that the many mechanical pumps were of perfect workmanship and all perfectly maintained—otherwise the advantage would be lost. In any case excellent distribution is now obtainable by the rival carburetter method.

There is, however, one merit which the injection system certainly has over any carburetter system using afloat. This arises in certain flying manœuvres when the accelerations due to the motion, added to the gravitational acceleration, upset the fine balance of the carburetter. In inverted flying, for instance, the injection engine has a better chance of steady operation than any carburetter type would be likely to have. But such attitudes are momentary and there is the immense momentum of the airscrew to carry the engine over dead points. For the injection system it is also claimed that there need be no throttling whatever of the entering air, that the supercharger has therefore an easier task, and that a somewhat higher ceiling can be attained; this is not a considerable point, as the throttling is slight, but it is certainly one of which one must not lose sight. Hence it will be seen that as between the two systems the pros and cons are fairly evenly balanced, but if one compares the total number of separate mechanical parts needed by each there is little doubt that the carburetter wins.

## Laissez-Faire

WORDS have a provoking way of changing their meanings. They start out with the best intention to stand for one thing and one thing only. Then someone mishandles them through malice or ignorance and their bloom is sullied. No longer simple and ingenuous, their reputation tarnished, they give themselves up to duplicity; but their falling from grace does not end there. Each of the two meanings begins to split up into further meanings, like the chromosomes in a living cell, until finally there may be as many meanings and shades of meaning as there are users of the words. Then the lexicographer steps in. He tries to peg each meaning down to something fixed, immutable and definite, but only succeeds in simple cases. He is safe enough with teapots or hansom cabs, but face him with "glory" and he is almost as elastic as Humpty-Dumpty was with that word on a memorable occasion, or with "Truth," and his ideas are as vague as those of Pilate. He does his best, poor man, but after all he has to explain words *by* words; the blind leading the blind. One might hope for salvation if more people used dictionaries to fix meanings, rather than to find out how many ems there are in committee, how many esses in Mississippi, or to discover a six-letter word that begins in BO and ends in M. But we doubt it. Once you get away from subjective things like *crêpe de chine* or brass tacks and find yourselves in the objective realm of ideas, no two people will ever receive exactly the same emotional impulses from the same words.

*Laissez-faire* is a case in point. A great French economist, Gournay, invented the phrase *laissez-faire, laissez-aller* for a specific purpose in French economics in the first half of the eighteenth century. We need not bother about his purpose, for it had nothing to do with the English economic system of that time. It was a French affair only, and the phrase was apt. But, later, someone pulled it across the Channel, dropping half of it on the journey, and it became *laissez-faire* and the handle for an economic principle which had long existed. So it carried on for a good many years in no derogatory sense. It expressed the sturdy independence and individuality of your Englishman and his extraordinary ability for making the best of events as they turned up. It expressed particularly his objection to being ordered about and managed. He insisted upon his right to do what he liked with his own and to do it in his own way and his own time. In Victorian days that was deemed quite fit and proper, and it must be confessed that in the circumstances of the time it worked uncommonly well. The "Encyclopædia Britannica" admits that *laissez-faire* was "genuinely relevant at the end of the eighteenth and the beginning of the nineteenth century, when the statute book was cumbered with vexatious and obsolete laws" and, of course, Mill with his love of liberty stood up for it. In fact, for over a century it expressed the Englishman's innate conviction that he had not only the right from heaven to be his own master, but served England better when he was. He did not want the Government to help him or to meddle in his business. He wanted it to stand aside and leave him alone. If he won he won by his own exertions, if he lost he was ready to take the knock himself. He believed that the success of industry resulted from the success of individual units and he abhored amalgamations. Even at this day there are thousands of employers and business men, and workpeople too, who detest being regulated and regimented, and in their heart of hearts believe in the kind of liberty that was meant by *laissez-faire*.

But the word has fallen upon evil days; it would no longer recognise itself. It is no longer the definition of an economic system, but a term of obloquy—like Gengulphus—who, as the little girl said, was "Once a saint and afterwards a swear-word." It stands now for all that is anathema to those who are convinced that the world can only be saved by planning in advance; people who are miserable if they cannot carry out a campaign "according to plan"; people who detest muddling through and hate it most when it is most successful; people who want the high gods in the Olympus at Westminster to organise everything years ahead, to docket and record, and analyse and to have thousands of forms with thousands of names on thousands of dotted lines. That is what has happened to poor *laissez-faire*. No longer does it stand for a fine quality, the freedom and independence of individuals, but is a mere word of despite to throw at those who rebel against control. To quote once more the "Encyclopædia Britannica," it has become "ludicrously inadequate" when applied to the actual economic life of the present day. Thus has the mighty fallen. Let us then, whilst we gird ourselves to mollify the onslaughts of its fiercest opponents, drop a tear upon its tomb and pay a passing homage to its epitaph, for it, in its days, knew greatness.

# Light-Weight Steam Plant

By R. C. McLEOD, A.C.G.I., A.M.I. Mech. E.

IN THE ENGINEER for July 18th there is an editorial article headed "Air and Sea." It draws attention to the importance of providing as much deck armour as possible, and in order to do this it is suggested that, where possible, weight might be saved by the use of light alloys. A lot of weight reduction is possible in certain directions in the machinery, but one fundamental point sets a limit to the gain from reduced machinery weights, and that is the question of the ship's stability. If the machinery is to act as ballast, a reduction cannot be made to its weight without readjustment in some other way. If, however, in new designs arrangements can be made to secure stability with added deck armour and light-weight machinery, there seems to be no technical reason why something should not be done to provide the lighter machinery.

One of the things which is difficult to understand is the way in which an industry with a problem to solve evolves a technique of its own to solve the problem, while at the same time another industry, which could very well take advantage of the new technique, continues on its own way, too proud to learn from others who can certainly teach it something. The result of living in "watertight compartments" is that much work is done which could be done very much better if the techniques of the various industries were applied in all cases where they are suitable.

Steam power plant of the conventional kinds is one of the worst examples of the parochial outlook, and some of the steam engines made at the present time are a complete anachronism.

Take, for example, the so-called high-speed vertical enclosed forced lubrication compound steam engine. We see cylinder covers an inch thick held down by ¾in. studs on an engine of perhaps only 50 H.P. There seems to have been practically no improvement in the design of engines of this type during the last thirty years.

There is no fundamental reason why internal combustion engines should be made in one way and steam engines in another, yet we find that makers of the two types of plant are laws unto themselves. A few pioneers in the field of steam road transport, such as Clarkson in England and Doble in America (to mention only two), have shown some of the possibilities of light-weight steam plant. Within the last ten years the Bessler brothers of America have flown an aeroplane with a light-weight steam plant, which was made of ordinary materials. The engine used was not built for an aeroplane, but for rail transport, and yet it was light enough for aerial propulsion.

So far turbines have not been mentioned, but it is really for machines of this kind that the writer is trying to preach the gospel of lightness.

All turbines working at reasonably high pressures, having speeds and diameters suitable for their power output, give an immense amount of power per pound of rotor weight. Their power-weight ratio only becomes unsatisfactory, when the beautifully light rotor is encased in a casting, whose thickness is more often dictated by the foundry than by considerations of stress and stiffness. Other parts of the turbine, such as bearing pedestals and control gear, are nearly always made of castings, whose weight is out of all proportion to the work they have to do. There is another cause of excessive weight, and that is the insistence by some buyers on having a machine running at a speed which is much too low for the power output.

If a turbine is designed with freedom to choose the speed and method of construction, enormous weight reductions are possible; and with back pressure units machines weighing less than a pound per horsepower are a practical possibility. The ways by which these weight reductions are secured come under the following four headings:—

(1) Speed and size suitable for total steam admission (or as nearly as possible).

(2) The use of hardened gears as used by the aeroplane and motor industries.

(3) Thickness of static parts to be designed from the point of view of stress. Stiffness to be obtained by suitable shape.

(4) Bolts and studs to be more closely pitched and of much smaller sizes than usual.

Practically all the essentials under these headings are anathema to the older generations in the so-called heavy engineering industry, and their influence is one of the obstacles to progress along the lines indicated. Flexibility of mind is necessary for all progress, and it is fortunate for this country that at least some of its engineers have had this quality.

Although that genius, the late R. J. Mitchell, could hardly be classed as the older generation, it is noteworthy that he started in a locomotive works and finished his life at the early age of forty-two with the design of the "Spitfire" and the winning of the Schneider trophy to his credit.

When users and builders can be made to believe that the time is ripe for weight reduction there is no reason whatever why we should not at once proceed with the building of machines which are more in keeping with the times.

All this may sound to some to be a rather sweeping statement, but in its support the following arguments can be advanced.

(1) Without hardened gears the motor and aeroplane industries could not exist. What has made them possible must improve the turbine art. The present use of soft gears is like trying to make roller bearings of mild steel.

(2) Again, the motor industry could not have reached its present state of perfection without the use of steel pressings. These could be used in turbine construction to replace many heavy castings.

(3) Small nuts and bolts need not all be twisted off by the "ham-handed"; it is only a matter of training. There are practically no large nuts and bolts in an aeroplane engine, and their reliability can hardly be questioned when they are trusted to carry passengers over hundreds of miles of land in flying boats and hundreds of miles of sea in landplanes. A superb example of small bolt art is the big end assembly of a Rolls-Royce "Merlin." When one considers the result of a failure of one of these bolts the reputation of Rolls-Royce is ample proof of the adequacy of small bolts.

Nearly twenty years ago the writer started to build a turbine on motor-car lines, and it has now been finished for some years. It has done a considerable amount of running on a brake load but so far has not been put to the use for which it was built. Although the design is now old and capable of much improvement, it only weighs about 1 lb. per B.H.P.

Concurrently with the experiments on the home-made turbine, the designs of many marine auxiliaries were considered, and it was found that turbine and gear units could be made, having a weight of only one-tenth of those built on the generally accepted lines.

A further step in the direction of light-weight possibilities has been considered for the propulsion turbines of a small high-performance steam vessel, about the size of a C.M.B. The turbines are designed for a two-shaft scheme giving 3000 H.P. per shaft, the weight of each unit being 3700 lb., which includes turbine, gear and condenser, but not circulating and extraction pumps or thrust block.

The auxiliaries for such a vessel present a simple problem and could be made very light. If a suitable boiler is available there seems to be a prospect of invading the territory of the petrol engine by a steam plant using a lower grade of fuel. If the heating surface of the boiler can generate 25 lb. per square foot on an average, at the maximum rating, it means 2·5 H.P. per square foot (taking the turbine consumption as high as 10 lb. per H.P.). Assuming the thickness of the heating surface is 0·08in., it gives a weight per square foot of 3·3 lb., *i.e.*, 1·32 lb. per H.P. for heating surface alone. It ought to be possible to make a boiler with a total weight of not more than twice that of the heating surface. On these assumptions the weight of the turbine, gear, condenser and boiler totals 3·87 lb. per H.P. If the feed, circulating and extraction pumps are included the weight of the power plant would be a little over 4 lb. per H.P. A weight/power ratio of this order makes a planing type of hull possible.

Like everything else, the light-weight turbine has its limitations, and as size increases a hardened gear may not be possible. A further limitation is that with increased linear dimensions the weight/power ratio will increase, the power being proportional to the diameter$^2$, whereas the weight must vary as the diameter$^3$ (provided the turbines are geometrically similar).

When the turbine becomes large enough the required thicknesses of many of the stress-carrying parts become such that they can be made from steel castings, and only the lightly loaded parts would be made by fabrication or pressings.

In the design of rotors relatively high stresses are accepted because there is no escape from them, but generally the static parts of turbines are designed with such generosity that the stresses are often very small indeed. Advocates of heavy designs may argue that the casing must be designed to resist steam pipe thrusts, &c.; this is a most important point, but much can be done by careful planning of the pipe lay-out and supporting the turbine on kinematic principles.

When the writer has discussed light-weight turbines with various people some are inclined to treat the idea with scorn. In cases where portability is important it certainly seems to be worth while; for high-performance steam vessels there is scope for much development.

## Literature

*Electric Power Stations.* By T. H. CARR, A.M.I.E.E., A.M.I. Mech. E. In two volumes. London: Chapman and Hall, Ltd. 1941. Prices: Vol. I, 30s.; Vol. II, 32s. net.

THIS is the first important work on British power station practice which has appeared since Sir John Snell's "Power House Design" was published in the early 'twenties. The need for an up-to-date book of this kind has long been felt. To quote from the Foreword, contributed by Sir Leonard Pearce, "The advances which have been made in power station design since the beginning of this century are almost staggering, and it is necessary sometimes to have a reference book in order to keep up to date with latest developments in many fields. So great have been the advances in the many branches of engineering involved in the construction of electric power stations, that there has been a great tendency for individual engineers to specialise in a particular branch . . . and the present book will, I am sure, be of great assistance in enabling specialists to maintain contact with branches of engineering other than their own."

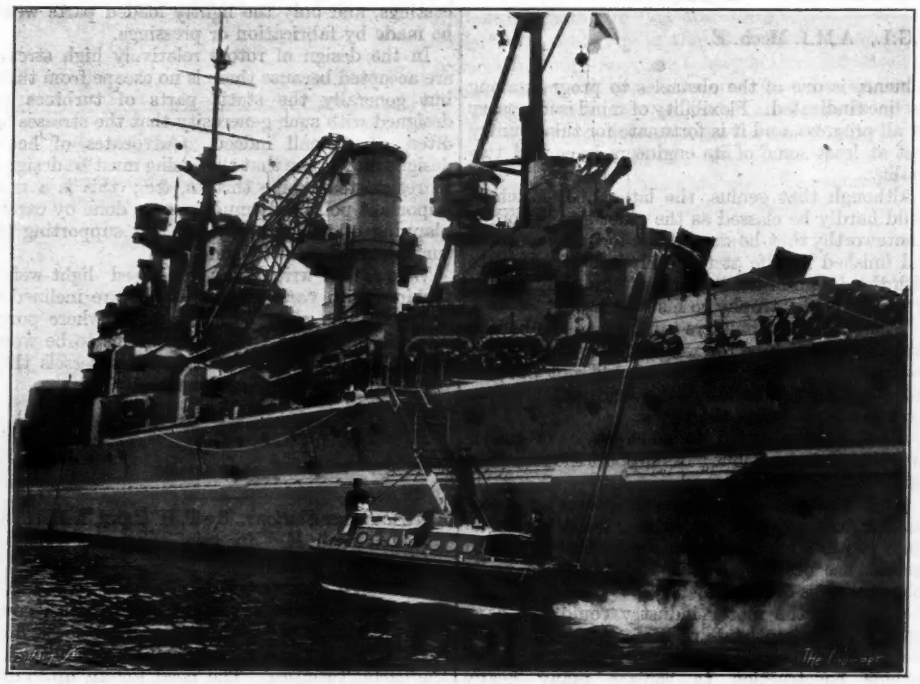
"Electric Power Stations" was written by Mr. Carr, who is well known as a regular contributor to the technical Press of articles on various aspects of modern practice in the planning of steam power stations, at the request of the publishers, and, as he says in his Preface, it "deals with the general principles governing design, construction, and operation." So much for the aims of this new and authoritative work. Now as to their fulfilment in a book of twenty-three chapters, covering some 800 pages in two volumes.

The opening chapter, entitled "Fundamentals of Station Design," occupies just nine pages, and concludes by citing a mere four references to the literature on this subject. In this chapter the choice of steam pressure and temperature is dismissed in a paragraph of eight sentences and a table giving particulars of the steam conditions and unit ratings of the more important British power stations. The author does not mention the classic papers by Mellanby and Kerr, Law and Chittenden, or Guy. However, he makes an attempt at dealing with this all-important subject in the chapter on turbines. Here there is a section, under the subtitle "Theoretical Considerations," where the effect of steam pressure and temperature on thermal efficiency is treated after a fashion. The transition from Carnot's to Rankine's cycle is made by way of the following curious sentence: "The work done per pound of steam is the result of the heat units contained therein, since the temperature does no work and is merely a record of the units combined."

While it is no doubt easy to criticise in this way, it does seem clear that when the author in his Preface speaks of "design," he really has in mind "planning," on the basis of more or less well-established design practice. Viewed from this standpoint, Mr. Carr's treatment of what is admittedly a very wide subject becomes quite unexceptionable. The first volume covers civil engineering works and buildings, circulating water systems, cooling towers, coal and ash-handling plant, boiler plant, pipework and turbines. The chapter on boiler plant includes a good account of the La Mont and the Löffler forced circulation boilers, but makes no mention of any other high-pressure types, such as the Benson, Velox, or Atmos boilers.

The second volume, in turn, deals with alter-

## H.M. BATTLESHIP "KING GEORGE V"



nators, condensing plant, feed-heating and water-treatment plants, transformers and reactors, switchgear, cabling and cables, lubricating, insulating and fuel oils, station auxiliaries, protective gear, station lighting, commissioning and testing of plant, organisation, station costs, and fire fighting and A.R.P. The treatment of alternator reactance is so curt as to be almost valueless, for the distinction between synchronous, transient, and sub-transient values, although defined, is not explained by reference to a typical short-circuit oscillogram. The calculation of reactor ratings and fault kVA is a useful addition, although the choice of symbols for the individual reactances is unconventional to the point of crudity in a work of this standard. No reference is made in the bibliography to the many informative articles by R. T. Lythall, nor to his "Calculation of Fault Currents," which is by far the best contribution to this subject. The new "J. & P. Switchgear Book" is also absent from the bibliography at the end of the chapter on switchgear, although the corresponding book on transformers is cited in the preceding chapter. By an unfortunate oversight, too, machine ratings throughout the book are given in mW and mVA, where MW and MVA are obviously intended.*

Apart from such blemishes, Mr. Carr's new book evinces a thorough grip of his subject, and it has been written with a care to present all that is best and up to date in our power station practice. His descriptive treatment is clear and straightforward, the chapters are packed with useful data and information, and the many diagrams and illustrations really enhance the value of the book as a work of reference. The author's task has been far from an easy one, but he has fulfilled it in a manner that does credit not only to himself, but to our engineering literature. There is no other comparable work to which power station engineers, consulting engineers, designers, operatives, students and others can turn for this information.

## H.M.S. "KING GEORGE V"

In an article which was published in our issue of January 31st we gave a broadside view of the new battleship "King George V," together with as much technical description as may be given with regard to her interesting features of design and construction. The accompanying engraving is taken from a photograph of his Majesty the King leaving the "King George V" after his recent visit to the Home Fleet in Northern waters, and is just released by the Admiralty. It is of interest as showing more detail of construction than is to be seen in views of the ship hitherto given.

Alcohol for Power.—A technical committee of the Canadian Chamber of Commerce has submitted a recommendation to the Government for setting up an experimental plant for the production of power alcohol from wheat and other surplus agricultural products.

* B.S.I. Capital M = Mega

## The Combustion of Tar and Its Products*

By W. KIRBY, B.Sc., A.I.C.

In these anxious days engineers have to face many problems, not the least being that of fuel. In the search for alternatives to coal, petroleum oil or coke, it is not surprising that tar and its derivatives should be considered.

Probably the engineer draws up a list of fuel similar to that given in the following table :—

| Fuel. | B.Th.U. per pound. |
|---|---|
| Coal | 15,000 |
| Coke | 12,300 |
| Breeze | 10,000 |
| Briquettes | 11,000 |
| Peat | 8,500 |
| Wood (sawdust) | 9,000 |
| Petroleum | 19,000 |
| Tars | 16,000 |
| Tar oils | 17,000 |
| Natural gas | 18,000 |
| Coal gas | 15,000 |
| Blast-furnace gas | 1,500 |
| Producer gas | 2,500 |

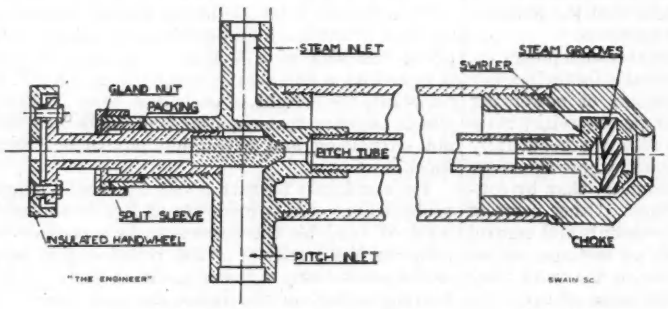
In this paper only one of these fuels is being considered, namely, crude tar and its products. There are two main sources of coal tar; from one it is a by-product in the manufacture of gas; from the other it is a by-product in the manufacture of coke. In quantity they are roughly equal and total 1¾ million tons, being 4 per cent. of the coal carbonised.

The physical properties of these two tars resemble one another sufficiently closely to make it unnecessary to make any distinction in their treatment. The quantity of tars produced in other than gas and coke oven works is too small to make any serious contribution to the fuel resources of this country.

Hot crude tar is removed from the gas made in vertical retorts by allowing it to flow away from the plant by way of a seal (to avoid loss of gas) into underground storage tanks. From there it is conveyed to the tar works by water, road or rail. Here the tar is boiled, thereby distilling off water and low-boiling oils, which are not lost, but recovered by cooling the steam and oil vapours in a condenser.

When the desired quality of tar is reached the distillation is stopped and the residue left in the boiler or still is transferred to storage.

* Institution of Engineers-in-Charge, July 4th.




BURNER FOR PITCH FUEL

Besides removing water, the most important change brought about in the tar by distillation is that its viscosity has been greatly increased. In distilling off 10 per cent. of oils the viscosity rises from 2 to 35 seconds and if a further 10 per cent. is distilled off the viscosity goes up to 800 seconds. The peculiarities of tar as a fuel are as follows :—

(1) At ordinary temperatures tar will not flow freely through a pipe. Means must be taken to warm the tar in order to get freely flowing properties.

(2) The possible presence of water must be guarded against; the limit is usually 0·5 per cent. and amounts much in excess of this figure result in intermittent combustion punctuated by explosive re-ignition of the issuing stream of tar.

(3) Tar is not completely liquid at any temperature. When examined under the microscope it is seen to contain numerous black particles invisible to the naked eye. By certain methods these particles are found to consist of highly concentrated carbon compounds, the carbon percentage being as high as 97. These particles are known as "free carbon." Where "free carbon" is present in large quantity the tar is more liable to burn in an erratic way due to coking of the tar at the nozzle of the burner.

(4) Tar is liable to contain clots presumably built around free carbon nucleii, which may cause variable flow in the burner.

(5) The high percentage of carbon as compared with coal necessitates a larger volume of air for complete combustion.

(6) In common with all liquid fuels, efficient combustion can only be secured by breaking up the liquid stream into fine particles.

Coal tar is admittedly a difficult fuel to burn and under normal conditions no incentive exists to overcome these difficulties.

When coal gas was first manufactured on a large scale gasworks were embarrassed by correspondingly large quantities of tar for which no market had been developed. One method which readily suggested itself was to burn it by pouring the tar on an inclined fire sill placed in the furnace. The tar partly vaporised and was burnt in passing over the fuel bed. From time to time the non-vaporised portion or coke was pushed into the furnace. It was claimed that 2 cwt. of tar burnt in this way carbonised 1 ton of coal. The problem of tar burning was revived whenever tar became a glut in the market. The desirability of thoroughly mixing the tar with air before combustion cannot be too strongly emphasised. In 1886 the South Metropolitan Gas Company protected a method of using a jet of steam to pulverise the tar; in this year tar reached a record low value of 7s. a ton.

Atomisation of a liquid fuel is effected either by compressed air or by steam. Air atomisation is more costly than steam but in spite of this it is the method generally employed on marine boilers to economise fresh water. It has the advantage of rather better air control. The air can be low, medium or high-pressure.

Atomisation by steam is perhaps more widely used. The steam should be dry and be of constant pressure as variations in the pressure result in corresponding fluctuations in the quantity of steam used, the amount of air drawn into the furnace and the degree of pulverisation.

In the early designs of oil burners the supply of fuel was adjusted by a tapered rod terminating in a needle point where the burner end projected in the furnace. A needle valve of this type is easily bent out of shape, resulting in irregular adjustment of the feed and consequently the flame loses symmetry. A further disadvantage and probably a more serious one is that the adjustment being situated at the hottest part of the burner, coking of the fuel is liable to take place at this point with consequent interruption in the supply. It is for this reason that the needle is shaped to serve the dual purpose of valve and piercer.

In modern burners the valve has lost its needle-like appearance and is located in comparatively cool surroundings. The whole of the burner is readily withdrawn for cleaning from the body without disturbing any joints. Burners of this type are made of different capacities, some in actual use burning as much as 100 gallons per hour.

The theoretical amount of air required per pound of tar naturally varies with the elemental composition of the tar, but may be taken at 13 lb. On a basis of 12 per cent. carbon dioxide in the flue gases, this quantity is raised to approximately 20 lb. of air required per pound of tar to be burnt.

The lay-out of the plant accessory to the burner is of major importance. The importance of a low viscosity for satisfactory atomisation has already been pointed out. If we accept a viscosity of 0·5 seconds for petroleum fuel oil as recommended by American writers, this viscosity is obtained by a viscous tar (100 seconds British Road Tar Association) at a temperature of 60 deg. Cent.

The tar is generally warmed by a steam coil to the required temperature, which should be not less than 80 deg. Cent., and the pipe feed from the tank to the burner should be steam jacketed or threaded with an internal ¼in. steam pipe. Where the feed pipe is on the bottom of the feed tank it should be noted that there is a layer of unheated tar under the coil which may give rise to trouble. It is a good plan to divide the storage tank into two compartments to facilitate maintenance and cleaning without at the same time interrupting the fuel supply.

If steam be the atomising medium, the quantity used should not exceed 4 per cent. of the steam generated in the boiler; a figure of 6 per cent. indicates an inefficient burner. Proper adjustment of the steam, assuming correct air, can be made by observing the character of the flame. A white flame indicates excess steam, a smoky flame too little and a yellowish flame the correct condition.

### The Combustion of Pitch

The burning of pitch as a fuel may be regarded as a special case of burning tar.

Physically, pitch may be looked upon as a solidified liquid, which, on being warmed, gradually returns to the liquid state. It is important to remember that the liquefaction of pitch is gradual and that it is not a sudden transition from a solid to a mobile liquid, as is the case, for example, when naphthalene is heated.

The success or failure of burning liquid pitch depends very largely on the steps taken to avoid the intermediate viscous stage. The plant already described for tar burning must be amplified as follows :—

(1) A minimum temperature of 140 deg. Cent. for a pitch of 80 deg. ring and ball is essential.

(2) The burner should be pump fed.

(3) The burner or burners should be supplied off a "ring main." *i.e.*, a pipe through which the pitch is kept circulating from and back to the supply tank.

(4) The rather high density of pitch requires somewhat more steam than needed for tar.

(5) Burners of the needle type are not satisfactory owing to the greater frequency of coking at the nozzle.

Tar works are more favourably placed for using pitch as a fuel as the pitch feed tank can be supplied direct from the still at temperatures exceeding 200 deg. Cent. Where solid pitch has to be dealt with it is important that a filter be placed on the supply pipe and, in addition, the lumps of pitch should be charged into an open-mesh basket which can be made to sit on the steam coil in the feed tank. This precaution prevents the accumulation of foreign insoluble matter which may come from the pitch and choke the supply pipes and burner.

In this connection it has been found that a new installation when first put to work is almost certain to give disappointing results owing to dirt and scale in the piping being carried to the burner with disastrous results. By removing the burner and blowing steam through the piping for not less than half-an-hour it will be found that possible obstructions from this cause have been removed.

The method of keeping the piping warm may be an internal ¼in. steam pipe threading through the whole length or by an external jacket giving ½in. clearance. The latter method is cleaner and prevents any possibility of steam leaking into the pitch, but it is also more costly to install.

The pump should be steam jacketed and large enough to maintain a flow of not less than 500 gallons per hour through the ring main.

The pumping equipment should be duplicated in those cases, such as steam boilers, where continuity of operation is essential.

The ring main is connected to the pipes leading to the burners in such manner that the tar supply to any burner in the circuit can be stopped by valves suitably placed in order that solidification of the pitch in the feed pipes is prevented.

When the pitch burners are fitted in boilers the flues of a Lancashire boiler should be lined for 6ft. of its length from the door with a fire-brick lining arched at the crown in such a way that it is clear of the tube by 2in. or 3in.

A chequer-work fire-brick bridge should be built across the remote end of the lining to serve as an ignition arch.

Water-tube boilers require a protecting wall, serving as a "target" wall to prevent impingement of the flames on the tubes. This wall is open chequer-work to avoid too much damping and may conveniently be built some 10ft. from the burners. A suitable refractory is of great importance owing to high local temperatures. The target wall and floor should be of silica, the arches which are more remote may be semi-silica.

A satisfactory burner (Laidlaw, Drew) for burning liquid pitch is shown in the drawing. It should be noticed that the nozzle aperture regulating the quantity of pitch has been placed inside the burner in a comparatively cool location away from heat radiation of the flame. As the indication of the performance of a burner of this type, it has been found that the steam generated at 110 lb. per square inch is from 9½ lb. to 10 lb. per pound of pitch. This with a $CO_2$ concentration in the chimney gases of 8 per cent.

Labour and maintenance costs arising from clinker and dust deposits on the tubes do not, of course, arise.

In many installations the use of tar and pitch as liquid fuels is a change over from a petroleum fuel oil. Unless certain precautions are taken serious stoppages may develop. It has been found that certain petroleum oils when mixed with tar precipitate a glutinous asphaltic material, which, if allowed to pass into the pipe connections, eventually stops the flow. These deposits are so difficult to remove that it is usually necessary to renew the pipe work. To avoid any trouble of this nature the storage tank and all piping connected to it should be thoroughly drained whenever a change is made from petroleum to tar or from tar to petroleum.

Pitch can also be satisfactorily burned in the solid form. It is essential for successful results by this method that the pitch has a high melting point so that it can be pulverised into an impalpable dust and remain so at summer temperatures.

A satisfactory quality of pitch is one which melts at not less than 130 deg. Cent. Ring and Ball. Pitch as usually marketed melts at 80 deg. Cent. R. and B. The plant for burning pulverised pitch consists of a breaker of the usual type, reducing the pitch into small lumps passing a ⅜in. mesh screen. This crushed pitch is packed into a hopper feeding the pulverisers. A satisfactory type is that known as the "British Rema." In this apparatus the pitch is reduced to dust, 90 per cent. passing a 200-mesh sieve. The rotating beaters which pulverise the pitch have controlled clearances to ensure the required degree of fineness. They have also the effect of a fan. A high velocity air current is set up which carries the pitch dust to the burner and at the same time serves as the primary air supply. In the base of the pulveriser is an additional fan providing an air supply surrounding the burner jet.

The burner is extremely simple. It consists of a 2½in. open tube serving as the nozzle, placed inside a 4in. outer tube which supplies the secondary air.

The furnace details are in every way similar to those recommended for burning liquid pitch.

The controls are first the quantity of pitch burnt; this is varied by increasing or reducing the feed of broken pitch to the pulveriser and, secondly, the volume of secondary air. A damper in the secondary air pipe over the burner adjusts this factor. The quantity of secondary air is regulated to maintain ignition of the pitch 6in. away from the nozzle.

Some of the striking differences between liquid and solid pitch burning are that the latter burns quietly, the continuous roar of steam atomisation is noticeably absent. The burner has no machined parts nor glands to be kept tight, with the result that the general appearance is cleaner. The flame is a softer type and does not resemble a blow-pipe flame on a large scale.

The disadvantages of this method are that the installation commits one to using one fuel, whereas a liquid pitch burner can be equally well used for any liquid fuel, also the supply of pitch of the necessary high melting point is limited to a few tar works and as a conseqnence this method is only used by pitch producers.

An alternative fuel to tar and pitch is a mixture of the two, roughly in equal proportions. This pitch-tar or pitch-creosote mixture is controlled by the Petroleum Board and supplies must satisfy their specification, particulars of which can be obtained from the Petroleum Board. The methods described for tar burning apply equally well to solutions of pitch in tar oils.

To justify the title of this paper a few remarks on tar oils are included.

Oils obtained from tar, particularly from certain types, are liable to solidify completely or partially when cold. The solid matter is readily dissolved on moderate warming, the solution being markedly different from pitch solutions. As previously explained, pitch solutions go through a viscous stage at moderate temperatures; on the other hand, creosotes have a very narrow viscous range. That temperature which is sufficient to dissolve anthracene and naphthalene need not be increased to reduce viscosity, but only to ensure a safe margin to prevent precipitation following the unavoidable fall in temperature in the fuel oil flow.

It will be appreciated that it is unnecessary to provide for a continuous circulation of this type of fuel, nor are strainers required.

Crude naphthalene is another tar product which has been burnt as a fuel when its value has fallen to an unsaleable figure. Pure naphthalene is a solid melting at 80 deg. Cent., the crude variety which would be burnt would probably melt at 60–70 deg. Cent. When melted it is very mobile and apart from keeping the temperature of the installation at 80 deg. Cent. or over it presents no difficulties in combustion. It has one peculiarity of subliming very readily, which would lead to heavy losses if kept melted in an open tank. The use of tar oils in diesel engines scarcely falls within the scope of this paper.

* * * *

In reply to a question, the author said that, on a cost basis against other fuels, outside, of course, tar works themselves, tar was definitely more expensive, the price ranging in the neighbourhood of £4–£5 per ton; this naturally put it out of court for some institutions. On the other hand, in one instance the change over from coke to pitch resulted in a great saving, largely due to the reduced cost in labour.

Although tar cost more than ordinary fuels, first cost in this, as in other cases, did not mean everything. It often paid to weigh up the advantages against cost and so get a favourable balance sheet.

Tar at the present moment was fairly plentiful. Under normal conditions there was not a large demand for pitch in this country, approximately 80 per cent. going to France, Belgium and Germany. But since its exportation was now cut off the tar producers were accumulating plenty of tar and pitch and were burning it in their own works to relieve the pressure on their storage.

## Chromium Plating of Cylinders*

The application of chromium to the bore of cylinders is not an easy job. It has taken quite a few years to develop it and there have been many failures, but it is through trial and error that a process proves itself.

The process must meet certain fundamentals :—

(1) The electrolytic coating must adhere perfectly.

(2) The thickness of the coating must, within limits, be equal all around and from top to bottom.

(3) There must be no tiny ridges for the piston or the rings to run against.

(4) The ordinary bright, dense coating of chromium is not suitable; it does not hold lubricating oil.

(5) In order to hold oil, it is essential that the chromium be very porous.

Each of those fundamentals is very important They are considered in detail as follows :—

The necessity for perfect adherence is so obvious that it hardly needs to be emphasised. With ordinary good workmanship it is not difficult to achieve. Proper cleaning and etching of the cylinder wall, together with proper tooling, will always give a good adherence. Anodes are cast and machined, and fixtures made to centre the anodes, as described in United States Patent No. 2,048,578.

Small cylinders or blocks are always arranged four to ten in one fixture if electro-plating is done on a production basis; large cylinders of, say, 20in. bore and over are treated one at a time.

A variation in cast iron may necessitate a variation in processing, particularly in timing, but that has to be discovered in each case. More difficult are large cylinders of 20in. bore and over, for several reasons. The surface structure of the cast iron may vary along the cylinder from top to bottom, hence—supposing such a variation could be traced—which it cannot—the processing ought to vary on one cylinder; but this is not feasible. The machining of such cylinders is never as accurate or as good as on smaller cylinders, and this automatically varies the processing. The usual method of machining the bores of large liners is not sufficient for chrome hardening. A ground or honed finish is required. Ports in two-stroke cycle engines are always difficult. The fact that a smooth honed surface and a rough cast surface adjoin demands a lot of the art. The edges of the port should be rounded off so as to plate a little inside the ports.

In this connection the following experience has been obtained :—A two-stroke cycle test engine with a chrome-hardened cylinder running at full load had been plated without rounding off the edges of the ports so that the coating of chromium ended abruptly from ribs between ports to inside ports. After a 2400-hour run it was found that there were round bare spots where the chromium had disappeared at the corners of the ports in the direction of the air flow. What had happened? Corrosion had taken place, gradually and very slowly undereating the iron, so naturally the chromium under the full ring pressure had broken down particle by particle. The only way to prevent this is to round off the edges, allowing chromium to be plated inside.

The fundamental necessity for equal thickness is also obvious. If the thickness is not equal the bore cannot be honed clean and the rings and piston will come in contact with the rough chromium of some 1400 Brinell hardness and will abrade rapidly. Equal thickness is obtained by making suitable fixtures, centring the anodes well, and insulating those parts that should have no coating. The anode must be tapered in such a way that the lower end is slightly smaller in diameter than the upper end. This serves to counteract a tendency to deposit more chromium in the end of the bore that is down in the solution. Depositing inside a bore, there is a tendency for the chromium to taper off for the last ½in. at top and bottom of bore. In most engines the tapering off at the bottom does not matter, but it cannot be allowed to taper off at the top. However, an extension to the bore takes care of this. It takes practice to arrive at the proper technique of depositing just enough chromium, *i.e.*, from 0·002in. to 0·004in. minus on the diameter measured on the rough, so as to allow for honing to size.

The thickness of chromium required varies from 0·006in. to 0·040in. as measured on the diameter. In practically all the smaller engines of, say, under 6in. bore, 0·006in. to 0·008in. is common practice, and this will last the lifetime of the engine. The proper thickness depends upon the conditions under which the engine will run and the expected lifetime

* From a paper by H. van der Horst, A.S.M.E., June, 1941.

of the engine. An automobile engine rarely has a longer life than 2000 running hours, but a large marine diesel engine is still supposed to be "brand new" after 2000 hours.

The third fundamental is the necessity to avoid ridges. This has been dealt with in the explanation of the necessity for equal thickness. Such ridges may be very small and escape notice but unfortunately the piston and rings notice them and are scratched by the 1400 Brinell chromium.

The fourth and fifth fundamentals, to the effect that bright dense chromium is not suitable and that in order to hold oil the chromium must be porous, are interesting points. When this process was first being developed some years ago and was applied to high-speed motor-car engines, it soon proved all that had been hoped for it in regard to resistance to wear. At the same time, however, the chromium and the piston skirt nearly always scored. Every precaution had been taken to make a good job of it, and in this effort the cylinders were honed to a high polish at considerable pains. Events proved that this was wrong. A superior oil was used on recommendation of experts, but within a few weeks there were twenty-four engines on the test bed, and every one of them scored. At the same time other high-speed engines were performing very well on a very ordinary mineral lubricating oil. These were inspected and it was discovered that the chromium coating on these latter engines was full of little pits. This led to experiments in an effort to produce a chromium coating that would be the reverse of a dense, highly polished finish. After a long struggle these experiments led to success in obtaining a very porous coating of chromium, and since then cylinder scoring troubles have ceased. Contrary to a widespread trend of thought in regard to chromium coatings in cylinder bores, a dense, highly polished finish is no good.

In regard to this process it is often asked: What changes to the engine does it involve? Should there be any change in the piston clearance? What piston rings are to be used? What finish should be used on the liner or cylinder? What lubricating oils are to be used?

A short answer to these questions is: No changes at all. However, this is a bit too broad and it is worth while to review these matters.

It has already been mentioned in this paper that the bores should be machined smooth prior to chrome hardening by means of honing or grinding. The treatment could not be controlled closely enough if they were not. There is no change in the piston clearance. In a breakdown test at Olean, N.Y., there was no difference in the piston clearance, and yet it was found that the engine was not sensitive to reducing the lubrication to half the normal and to very abnormal cooling.

Regarding piston rings, all makes of rings may be used with one definite exception. Chrome-hardened rings should not be run on chrome bores; nor should nitrided rings or other very hard rings be used. Experience shows that chrome-hardened and nitrided rings cause scoring of the bore, the piston and the rings in a very short time.

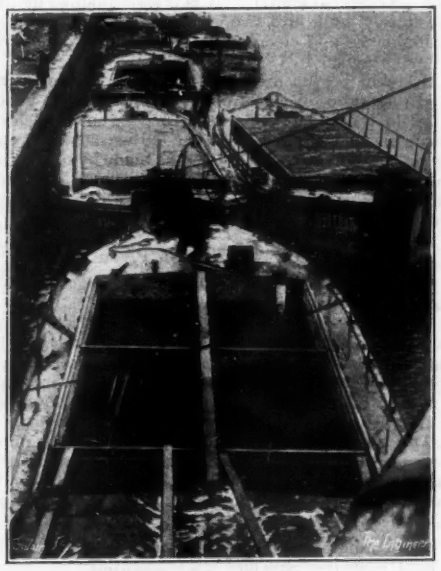
Which lubricating oils are to be used may be answered as previously, "Make no change." Superintendent engineers who have had some years' experience with engines fitted with chrome bores have come to the conclusion that the lowest-priced oils suited them equally as well as the higher-priced. Experience has shown that any lubricating oil that promotes the varnishing of the bore, the piston and the rings is definitely bad. It robs the process of one of its main advantages, the huge reduction in ring wear.

Some changes both in design and materials have been made by engine manufacturers applying this process. However, such changes are not a necessity. What happened is that after a year or so of experience those items in engine design that primarily were intended for wear reduction are discarded. First to be abandoned is the dry sleeve, which is entirely unnecessary and is a nuisance. Next is the use of a plain cast iron instead of alloyed irons, resulting in less cost and often in less risk of cracking. The use of non-ferrous material of a high thermal conductivity is being considered.

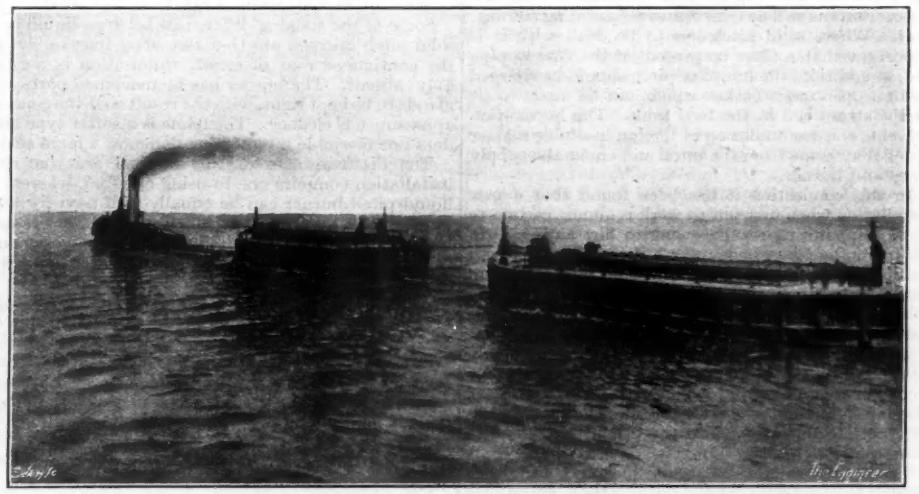
All in all it comes to this, that the process is much more an engineering than a purely electro-chemical problem. To conduct its technique, an experienced motor engineer, who would have to learn the electro-chemical side of it, would be as valuable as an electro-chemist, who must learn the motor engineering side of it. There are many difficulties to overcome, but the industry is used to that.

## Reinforced Concrete Barges

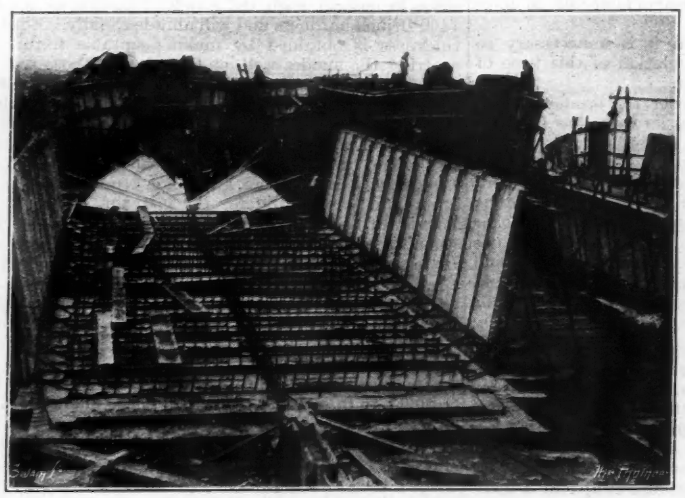
On Tuesday, August 12th, it was announced by Naval Affairs that a considerable number of new reinforced concrete barges have been ordered by the Admiralty, the majority of these vessels being of the pre-cast slab type of construction. A decision to build reinforced concrete barges of a design large enough to carry 200 tons of cargo was taken in the early months of 1940. Deciding factors were the bringing into the war effort of non-shipbuilding labour and materials, and the rapidity with which such barges can be built. It is stated that the cost of construction is not greatly different from that of a steel barge and under favourable conditions a barge built up of pre-cast slabs can be assembled and completed in about eight weeks. The type of barge adopted upon which the design has been based is that of the ordinary Thames barge. Modifications include ship-shaped ends, with an outfit and equipment which will be suited for use at different ports under varying conditions of service. The light weight of a reinforced concrete barge is about double that of a steel barge of the same deadweight carrying capacity, but it is interesting to note that the weight of the reinforcing material is only about one-third the weight of steel which would be required for the construction of a similar steel barge. In order to explore fully the possibilities of this type of vessel it was decided to order barges of differing constructional types. One of the types employs pre-cast slabs with the connecting frames and floors cast *in situ*. In the accompanying engravings we show various stages of construction and two of the completed barges in tow. The method of placing the pre-cast slabs in position for the sides and ends will be noted, also the reinforcing bars for the bottom. The side view of the barge clearly indicates the shape of the bow and the side and rubbing strakes, also the deck equipment, such as mooring bollards, hand rails, and the winch for the tow rope. The large size of the hatch is shown in another view. This type of barge is being built, we understand, at more than one yard, and the construction of such vessels should make a welcome addition to the number of smaller ships available for loading and unloading and the transport of goods.



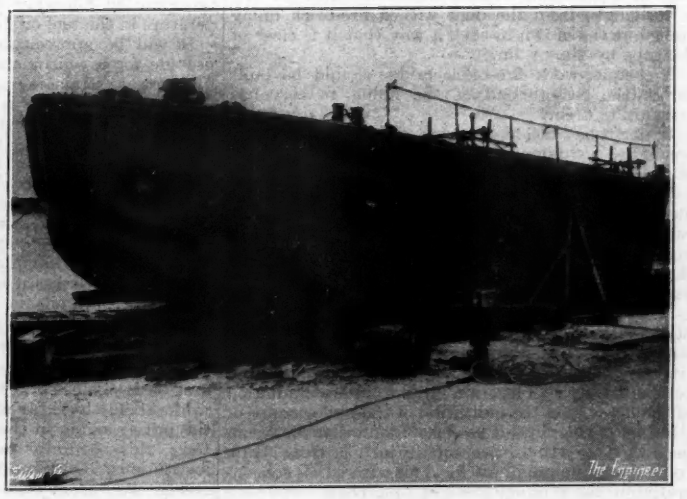
BARGES SHOWING HATCH CONSTRUCTION



TWO COMPLETED BARGES IN TOW



BARGES UNDER CONSTRUCTION



SIDE VIEW SHOWING SHIP-SHAPED BOW

## Motor-Cars and Lightning

WHILE a research engineer sat at the steering wheel, 3,000,000 volts of "lightning" were discharged into a car in a recent demonstration at the Westinghouse high-voltage laboratory at Trafford, Pa., without damaging the vehicle or injuring its driver. The engineer, Dr. Gilbert D. McCann, said that the demonstration with laboratory lightning proved for the first time that occupants of a steel-topped motor-car were safe from natural lightning attacks. Although the laboratory lightning stroke hit the car just 6in. above his head, he was safe from injury because modern steel car bodies are effective shields against lightning. If lightning struck a car on a highway, the electricity should be conducted through the metal body to earth without injuring the occupants. Before getting into the car Dr. McCann aimed the lightning gun—a 3,000,000-volt surge generator—at the unoccupied vehicle and fired several bolts. The only traces of damage after the test were small burn marks about the size of a pencil eraser on the metal top. When the lightning crackled against the car roof over his head, Dr. McCann felt no sensations, and probably heard less noise than the spectators.

Rubber tyres have nothing to do with the safety of the occupants, Dr. McCann explained. In his demonstration the electricity travelling from the car to the ground had to jump over a tyre. The petrol tank does not present a serious lightning hazard. The protected position of tanks on modern cars makes it almost impossible for them to be hit by lightning, especially since lightning seeks its nearest target, which would be the top of the car. Dr. McCann explained that when lightning struck the car in the high-voltage laboratory, the potential of the car and his body rose to about 200,000 volts, while the ground remained at zero potential. However, he felt no electrical effect because there was no difference in voltage produced across any part of his body. But a person on the ground touching the car or even standing near it during the lightning strokes would have been in danger because of the difference in voltage that would be produced in his body. All metal-top cars to-day are comparatively safe places during lightning. Trains and steel-frame buildings provide the same protection, because their framework constitutes an electrical shield.

For his experiments Dr. McCann used the laboratory equipment with which the insulators and protective devices that guard power lines and systems against lightning attack are tested. A transformer steps up the ordinary 150-volt laboratory supply to 100,000 volts. The current is rectified by high-voltage vacuum tubes, and then each of the surge generator's thirty capacitors is charged to 100,000 volts. Capacitors are charged in parallel. When they are charged they are discharged in series across sphere gaps, producing an accumulative voltage of approximately 3,000,000. The Trafford surge generator discharged a lightning current of 2500 amperes into the car. Lightning that strikes from the sky, Dr. McCann explained, is discharged from clouds having a potential of from 10 to 20 million volts, and the current in the strokes ranges between 500 and 200,000 amperes. If 200,000-ampere natural lightning with a voltage of several million had struck the car, he still would have been safe, but a hole might have been burned in the top by the intense heat generated.

## Metal-Coated Plastics

A PROCESS for metal-coating phenol formaldehyde mouldings, cast resin products, and laminated materials has been developed by Plastic Spray, Ltd., 3, Vere Street, London, W.1. The process is claimed to be not only a wartime expedient to replace metal cases and covers, but also to be such that it will have a permanent place in the electrical industry after the war. Tests made by the National Physical Laboratory at Teddington have proved that the electromagnetic screening properties of the metal film (zinc) are approximately the same as those of tin foil of 0·02 mm. thickness.

It is claimed that, not only does the metal-spraying process result in a great saving of metal, but also, because of the elimination of the extra metal screen, results in a considerable saving in space. A further advantage of metal-coated plastics is the reduced specific gravity and the consequent possibility of building lighter instruments, engines and machines. The metal-coating process, it is stated, joins the metal particles with the resin particles and therefore strengthens the surface considerably. At the same time, the adhesion is better than that previously obtained with galvanising.

The process by which the very fine zinc dust is applied gives a smooth surface, and it is possible, if the screening or conductivity properties have to be increased, to add a second and a third coat without an appreciable increase in the price. Plastics can be coated by the process, not only with zinc, but also with aluminium, copper or tin.

# Markets, Notes and News

**The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer**

### General Conditions

The British iron and steel supply situation has reached a highly interesting stage. The Battle of the Atlantic, with its risks to both our import and export traffic, has resulted in the adoption of an official policy of keeping the arrivals of raw and finished iron and steel and also of raw materials for the production of iron and steel in the United Kingdom down to a minimum, and at the same time the export of merchant iron and steel is banned except when essential to the prosecution of the Empire war effort. At present there are good stocks of material in the country, and naturally the Control is averse to depleting these more rapidly than necessary. The United States is being encouraged to supply our Empire markets with steel under the Lease-and-Lend Act, and this is naturally creating some anxiety in British trading circles as to whether we may lose these markets to some extent after the war. It is not anticipated, however, that this will prove to be the case, as in view of the enormous consuming capacity of that country America is not likely to concentrate upon the export of steel. The gradual decline in activity in certain branches of the British steel works is about to result in the closing of some works and the transfer of the workmen to other sections of the industry under the provisions of the Essential Work Order. The severe curtailment of our export trade in certain commodities is disappointing, but apparently the shipping situation makes this unavoidable.

### The Pig Iron Market

The pig iron market seems to have become a trifle quieter, probably in sympathy with the recession in demand in certain other departments of the iron and steel industry. Generally speaking, however, production is well maintained and supplies are passing freely into consumption, which is being closely regulated by the Control. which is, of course, more than ever concerned to limit imports of foreign pig iron. Certain stocks of imported pig iron, including, in particular, hematite, are held; but the Control is not anxious to dispose of these more quickly than can be avoided. The demand for high-phosphoric iron is well maintained, although the light castings industry is making only slow progress towards full recovery and is, in fact, unlikely so to do until the war is over and the civilian building trade gets on its feet once more. The improved demand for high-phosphoric pig can be traced to official action in urging consumers to use this material in place of other less plentiful descriptions. Some of the machinery makers are experiencing quiet conditions. In the Midlands the furnaces are busy supplying this grade of pig iron to other parts of the country, including those markets which used to buy elsewhere before the war. Basic pig iron, owing to the intense demand for steel, is extremely active, but supplies are satisfactory. The call for forge pig iron is quiet. In the Tees district the bulk of the production is restricted to basic iron, very little foundry grade being produced, so that the Midland producers continue to provide the area with good tonnages of this latter material. Consumers in the district appear to be adding to their stocks of foundry iron, and the Control is encouraging this policy. The local tightness in the supply of hematite appears to have been ameliorated to some extent. Refined iron is now substituted for hematite in some cases, but the Control is releasing fairly satisfactory supplies of hematite to approved consumers.

### The Midlands and South Wales

A distinct lull in new business is noticeable in one or two departments of the iron and steel industry. The demand for heavy joists and sections, which has been sluggish for several weeks, shows no signs of improving. This is principally because the constructional engineers have completed Government building jobs and large new contracts are scarce. The demand for sheets also has been affected by the completion of contracts for air raid shelters and no fresh outlet for steel of this description has developed. Most of the heavy steel works, however, are still working at capacity on priority orders and there is an insistent demand for plates. These are going in large tonnages to the shipyards, tank makers and wagon builders. The boilermakers are also busy and their requirements are on a heavy scale. The re-rolling industry has experienced a steady and active demand for small sections and is in a good position as regards raw materials. In many cases they have been able to accumulate stocks of semis and should be in a satisfactory position if wintry weather hinders transport operations. There is a strong demand for alloy and special steels from the munition and armament manufacturers, which looks like continuing for a long time, although there has been an expansion in the production of this class of steel. The requirements of the collieries are considerable although less than was the case a few months ago. Good quantities of arches, steel props and roofing bars, however, are needed for maintenance work. In South Wales some of the steel works would be glad to obtain fresh business, but this applies principally to the structural steel, tinplate and sheet sections of the industry. The decision to increase supplies of sheet and tinplate bars to the works has created some surprise, and it is suggested that this shows that the steel position generally has become somewhat easier. The tinplate trade is not active, since the restrictions on the use of steel and the difficulty of obtaining export licences have resulted in a considerable amount of export business being passed over.

### The North-East Coast and Yorkshire

This week is the usual holiday period in the Tees district, and ironmasters are taking advantage of the quieter conditions which have developed recently to close some of their plant and undertake much-needed repairs. It is not believed locally that the present quieter state of affairs is likely to persist, but this, of course, remains to be seen. The steel industry is now under official control and its output will not only be dictated by raw material supplies, which depend on shipping considerations to a large extent, but also by national policy, which must depend considerably upon war developments. War requirements for various products will fluctuate from time to time. For instance, the big demand for structural steel and sheets is passing—this was a phase of the early stages of the conflict when factories, hangars, barracks and other large constructions had to be put up. Steel for shells, bombs, aircraft, tanks, battleships and merchant vessels, however, is in heavy and increasing demand. Special alloy steels in particular are needed. Local makers are doing their best to co-operate in these changing conditions. Meanwhile, owing to the shipping situation, both imports and exports of iron and steel into and from Britain are being drastically curtailed. As far as possible contracts from the Dominions are being switched to the United States. The new American priority measures for the steel industry provide for due priority to be accorded to supplies of steel for Britain. Consumers of steel semis are believed to be building up stocks at the moment under official encouragement. In the Yorkshire district the holidays recently affected output, but this is becoming normal again and most works appear to have full order books. Makers of special steels are particularly heavily engaged. Good employment is also reported at the heavy engineering establishments with both the casting and machining departments well booked.

### Copper and Tin

The copper position in Great Britain changes little from week to week, and essential supplies of copper continue to reach manufacturers in adequate volume. In some directions the view is frequently expressed that if a still wider use of scrap were encouraged by the Control further economies in the consumption of virgin metal could be achieved. There is not a great deal of copper allocated for other than essential needs, but this must now be regarded as a normal state of affairs for the duration of the war. In the United States an official maximum price has been imposed of 12c. per pound, basis, delivered Connecticut Valley. This is in accordance with expectations. The July statistics of the American Copper Institute showed record deliveries of 143,089 short tons, although there was no expansion in the production either of blister or refined copper, which amounted to 82,870 tons and 86,879 tons respectively. Deliveries included 32,463 tons of copper imported from Latin America by the Metals Reserve Company, but there was also a substantial reduction in stocks of refined metal, which fell 23,790 tons on the month to 74,384 tons. . . . Important events have occurred in the international tin situation recently. The Metals Reserve Company in America has contracted with the Dutch East Indies for the supply of tin concentrates yielding 20,000 tons of fine tin, which will go to Texas City to improve the low-grade Bolivian ores to be used at the new Government smelter there. This will, of course, mean a reduction in supplies to the Straits smelters, which since the German occupation of Holland have been handling a good deal of Dutch East Indies ore. The American authorities have imposed official maximum prices for tin, the figure in the case of refined metal being 52c. per pound. A state of tension continues in the tin market generally owing to the uncertainty of the Far Eastern outlook, and the maintenance of Japan's warlike attitude. American importers are expecting an increase in war risk insurance rates, and in consequence have tended to operate cautiously. The British market has been rather quiet, little or no smelter selling having been in evidence in the open market recently.

### Lead and Spelter

The fact that substantial tonnages of Canadian lead are to be shipped to the United States by the recent arrangements with the Metals Reserve Company will not, it is understood, seriously interfere with supplies for Britain, as for some little time Canada has had a surplus of lead over her own and this country's essential needs. As far as supplies here are concerned the position remains fairly comfortable, although, as in other metals, only limited quantities are being allocated for other than Government requirements. The most active consuming trades still seem to be the cable and battery makers, whose products are in big demand in connection with the war effort. The building trade continues to absorb a lot of lead, but nothing like the quantities normally consumed in peacetime, and as Government factory construction seems to have passed its peak there is little likelihood of a further expansion in consumption in this direction. . . . There has been no material alleviation in the British supply position of spelter. It is true that the galvanisers are less actively employed than a few months ago, and that in consequence supplies of G.O.B. metal must have been released for use in other departments. The demand for spelter, however, is so large that all available metal continues to be readily absorbed, and not only is the entire Empire output going into consumption, but imports from the United States are still necessary to make up essential requirements. Allocations for other than Government needs are now small. In the United States the tangible signs of a larger output have been welcomed, but it is realised that consumption has been somewhat artificially held in check in recent months, and that the supply situation is likely to remain tight for some time to come. This is particularly so, as it is not yet certain that shipping facilities will permit the ready importation of foreign concentrates on a sufficiently large scale to enable peak production plans to be realised.

IRON ORE IN INDIA.—An iron ore deposit has recently been found in the Sukinda Estate of Cuttack, near the border of Keonjhar, and it is anticipated that in the near future workable deposits may be found close to the Orissa coast.

# Notes and Memoranda

## Rail and Road

GERMANY'S TECHNICAL PRESS.—Not content with muzzling the popular Press, the German Government has assumed control of a leading transport journal, *Verkehrstechnische Woche*, established in 1907. This has been renamed *Grossdeutscher Verkehr* and is now the official organ of the Reich Ministry of Transport. The policy of the paper has already undergone changes at the hands of Dr. Dorpmüller, Reich Minister of Transport, and Herr Kleinmann, his assistant.

PAYMENT IN KIND.—A curious innovation has been initiated in Russia's transport system. Hitherto freight rates for consignments in transit through Soviet territory have been paid in American dollars. Under the new plan freight rates for transit goods using the Trans-Siberian route, as well as to and from Iran, are payable in kind. For this purpose proportionate parts of the consignments are retained by the Soviet Railways and this sort of payment appears on the railway documents under the denomination of freight compensation in kind.

PRODUCER GAS VEHICLES.—The Secretary of Mines, answering a question in the House of Commons just before the recess, rather damped the advocates of producer gas for road transport by pointing out that the saving of imported petrol had to be balanced against the additional demand for steel and other materials which such conversion involves. Another limiting factor in any large-scale commercial development was the supplies of suitable fuel. Still, considerable progress had been made, both by road tests and by laboratory and other research, in extending the range of such fuels.

ROAD SERVICE.—Ninety years ago this month, on August 1st, 1851, the Great Northern Railway Company, says the *Railway Gazette*, extended its line from Royston to Shepreth and shortly after instituted a service of four-horse omnibuses to work between Cambridge and Shepreth, so giving a road-rail service from London to Cambridge. Even earlier than this the London and Brighton Railway Company carried its rail passengers by road coaches between Haywards Heath and Brighton. When Brighton was linked with the Metropolis throughout by rail in September, 1841, this road-rail service was discontinued.

STREET RAILWAYS.—At long last all the rails of the old New York Central Railway tracks have been lifted from the street surface on Eleventh Avenue, New York. Thus is completed after sixteen years of work and nearly a half-century of planning a scheme to get railway tracks off the streets of the West Side of Manhattan Island. The West Side improvement covered 13 miles of trackage and several large and small yards along the west side of Manhattan. In all, gradient crossings have been eliminated in 105 streets. Originally estimated to cost 139,000,000 dollars, changes made as the work progressed have brought the total cost to around 200,000,000 dollars.

TO SAVE WHITE PAINT.—The highway authority in Texas and South Dakota has been experimenting with a view to improving the visibility and durability of lane markings by rolling stone chips of a contrasting colour into a binder. The centre stripe may consist of a ¼in. thickness of crushed stone rolled into an asphalt primer coat. Stone of a colour in contrast to that of the pavement is used; dark stone is put on concrete or grey asphalt, light-coloured chips on black bituminous surfaces. The new lane marker costs about 14 dollars a mile for materials and application, compared with a minimum of 15 dollars for the usual painted stripe that must be renewed every few months.

VEHICLES DRAWING TRAILERS.—The Minister of War Transport proposes to amend the regulations dealing with vehicles drawing trailers as follows:—(1) All vehicles up to 30ft. in length will be permitted to draw trailers. Hitherto no vehicle exceeding 26ft. in length has been allowed to draw a trailer. This concession will be subject to the requirement that the combination of vehicle, drawbar and trailer shall not exceed 60ft. in length. The concession will not apply to articulated vehicles. (2) The maximum laden weight of a combination of vehicle and trailer will be 32 tons instead of 22 tons, as at present, on condition that the trailer is equipped with power-assisted brakes which can be operated by the driver of the drawing vehicle. These brakes must not be of a type which are rendered ineffective if the engine is not running, and a warning device will be required to warn the driver of any impending failure in the vacuum or pressure system. These concessions are being made on the advice of the Inland Transport War Council with the object of increasing the carrying capacity of vehicles during the present emergency, and they will be discontinued at the end of the war.

## Air and Water

UNDER ONE ROOF.—The Wright Aeronautical Corporation, of Cincinnati, Ohio, has completed in record time the largest one-storey industrial building in the U.S.A. Measuring 1320ft. by 1064ft., the structure is to serve as the machine shop and assembly building of a plant to produce most of the parts and to assemble and test fourteen-cylinder, 1700 H.P. Cyclone engines. The structure provides 1,468,000 square feet of floor space or nearly 35 acres under one roof.

ICEBREAKERS FOR SWEDEN.—Recent winters in Scandinavia have shown a tendency to be considerably colder and longer, causing severe ice conditions, for shipping both in the Baltic and on the Swedish west coast, and it has therefore been proposed to build three new State icebreakers. Two of these will be used for icebreaking at sea and have a displacement of about 1900 and 900 tons respectively, while the third should be of a large tugboat type suited for service in Lake Vanern. With these vessels the Swedish State will have five icebreakers of its own.

SWEDISH SHIPBUILDING.—The report of the directors of Kockums Mek. Verkstads A/B., Malmo, for 1940, states that the yard received a good flow of orders during the year. The work done was valued at 38·35 million kronor and the average number of workpeople was 3554.

ANOTHER HYDRO-ELECTRIC PLANT FOR ALUMINIUM.—The Tennessee Valley is one of the big water power areas of America, and is administered by a body known as the T.V.A. This authority and the Aluminum Company of America have reached an agreement for the construction of the Fontana hydro project on the Little Tennessee River in North Carolina. The agreement is subject to securing from Congress the necessary appropriations. The project will produce an estimated 100,000 kW.

## Miscellanea

INDIA BUYS—AND MAKES.—Last year India for the first time purchased acetic acid from the United States. Domestic output, however, has been increased by the installation of a plant at the Tata Iron and Steel Works at Jamabodpur.

INDIA TO CONTROL MERCURY.—To conserve dollar exchange the Government of India is to subject to import trade control mercury and mercury amalgams, and compounds and preparations thereof, excluding anti-fouling compositions. Adequate supplies to meet India's requirements are stated to be available from the United Kingdom or Canada.

SOVIET TUNGSTEN.—What are described as the largest molybdenum and tungsten workings in Europe have been opened in Kabardino-Balkaria, in the Caucasian Mountains, at the foot of Mount Terny-Auz. The deposits were discovered some years ago, and, despite geographical and other difficulties, completely mechanised mining equipment has now been installed.

A NEW ALLOY.—Primarily devised as a substitute for aluminium for milk bottle caps, a new alloy of tin plus 8·5 per cent. zinc and 0·15 per cent. nickel, has other possibilities, for it combines strength and ductility in a remarkable degree. The improved tin foil rolled from this alloy has two and a-half times the strength of ordinary tin foil, says the *Chemical Trade Journal*.

QUARTZ.—The U.S. Army and Navy Munitions Board has included quartz crystal on its list of strategic materials essential for national defence purposes. Quartz crystal has a wide variety of uses, but its military use is in radio transmitting and receiving sets for controlling the output frequency of the radio transmitters and the response frequency of the radio receivers and in frequency meters.

FOR FACTORY LIGHTING.—After a long period of research and experiment, an American company has perfected the production of glass blocks, which can be built into factory walls so as to take sunlight from any altitude position and refract it above the horizontal upwards toward the ceiling. Although prismatic glass is not new, these glass blocks for the first time make it possible to seal hermetically the prismatic surfaces so that they are free from dirt and the corrosive effects of the atmosphere. Up to 60 per cent. of the air in the blocks is exhausted before sealing.

FRENCH INDO-CHINESE TUNGSTEN.—Japan's Far East moves have drawn attention to the tungsten deposits in French Indo-China. Deposits in the mountains of Pia-Cuac in Tonkin account for approximately 90 per cent. of Indo-China's production. The mines are operated by a group of French mining companies. Before the war the wolframite ore was sent to Europe for concentration, but it is now being treated locally. Since September, 1940, the trade has been under Government control. In 1939, of the 500 tons of ore exported, France took 393 tons.

NEW MINT FOR INDIA.—The Government of India has approved an expenditure of Rs. 64,50,000 for the construction of a new mint at Calcutta. Owing to the increased demand for coinage caused by the war, the existing mints at Bombay and Calcutta can no longer meet call. The new mint, which is to be built on a site to be leased from the Calcutta Port Commissioners, would in the first instance be for silver coinage only. It will have a normal capacity of Rs. 6,00,000 per day or approximately double that amount when working full overtime.

TRACKING A TOWER.—Tracking is an American term for transporting a structure from one site to another, and some unusual conditions surrounded the recent moving by a Los Angeles power and light company of a right-angle tower, carrying two 110,000-volt circuits of 500,000-cir. mil copper cable and a ¼in. steel ground wire. Reconstruction work by Army engineers necessitated moving the tower, which was done with hydraulic jacks, by means of which the 30-ton tower was raised so that 1½in. steel rollers with flanges could be placed between four moving shoes and the four I-beam tracks along which the tower was moved 22ft. to its new concrete base.

CEMENT AND CARBON BLACK.—Research at the Mellon Institute suggests that the use of carbon black in the manufacture of cement has definite advantages. The colloidal carbon assists in the grinding operations; with as little as 0·32 per cent. of carbon black added to the clinker the fineness of the cement was increased by 30 per cent. when the grinding time remained constant, or, when the product was ground to a constant fineness, the grinding time was decreased by 28 per cent. When the dosage was stepped up to 1 per cent. the improvements mounted to 50 and 34 per cent. respectively. The colloidal carbon used was in the form of tiny pellets. When added in the proportion of 1 per cent. the material did not, with the exception of colour, appreciably alter the consistency, setting time and soundness of the cement and had no noticeable effect on its resistance to alternate freezing and thawing.

JAPAN TURNS TO CHILE.—According to American reports, the Compania Mineral Punitaqui, of Chile, has contracted with Japanese interests to deliver immediately 2 tons of mercury and 200 tons of concentrates containing mercury, copper and gold. The company is prepared to deliver from 15 to 20 tons monthly.

THE *N.Q.B.*—It is possible that the *Newcomen Quarterly Bulletin* has appeared for the last time, at least for the duration of the war. The Council will not come to a decision until it meets before the opening of the 1941–42 session, but it is unlikely that anything will be published in October. The *Bulletin* was begun two years and a-half ago to provide a link with American members. It has served that purpose, but it has become increasingly difficult and expensive to maintain the contact regularly, and the Executive Officers in the United States have suggested suspension of publication for the time being.

MORE ALUMINIUM FOR AEROPLANES.—The United States has in hand for defence purposes no fewer than eight new plants to produce a total of 600,000,000 lb. of metal annually. Two plants, one to produce 85 million pounds and the other 55 million pounds, will be built in Oregon and Washington; two will be located in Upper New York State, to produce 100 and 50 million pounds respectively. Power for these two will be purchased, but ultimate permanent power for both these plants is planned to be obtained from the St. Lawrence development. Plants to turn out 100 million pounds each are to be constructed in Arkansas and Alabama.

SILVER IN INDUSTRY.—It has been estimated that there are in India 110,000 tons of idle silver—say, 3200 million oz. Silver, it is argued, could be used as a substitute for many of the so-called industrial purposes that normally are met by tin, assuming that the factor of price be secondary. Silver-plated material can be substituted for tinplate; silver alloys can be used in place of tin alloys for bearing metals and for soldering and brazing. Faced with the problem, the physical metallurgist should be resourceful enough to produce alloys containing silver that would satisfy most requirements where tin was formerly used.

TO PREVENT SABOTAGE.—The Commonwealth Edison Company has organised a service of radio patrol cars manned by selected trained guards to guard Chicago's electricity supply system. In all, 209 men are now engaged in patrol, watch service and other anti-sabotage activities. Sixty-eight of the 209 anti-sabotage employees on the Edison pay roll are licensed radio operators. All are subject to rigid examinations and they also undergo, under police supervision, an intensive training course embracing such subjects as theft and fire prevention, first aid, report writing, legal terminology, technique of arrest, search and self-defence.

## Personal and Business

THE Minister of Supply has appointed Mr. G. Spencer Summers to be Controller of Area Organisation.

SIR EDWARD G. H. COX has been appointed an additional director of Edmundson's Electricity Corporation, Ltd.

ALUMINIUM UNION, Ltd., has taken premises at Grosvenor House (Eighth Floor), Park Lane, London, W.1. Telephone, Grosvenor 4941.

MR. T. S. PEACOCK will shortly retire from the position of managing director of Guest, Keen and Nettlefolds, Ltd. He will remain deputy chairman of the company.

MR. C. S. OLIVER, of Armstrong-Siddeley Motors, Ltd., has accepted the invitation of the Minister of Aircraft Production to become Chairman of the Coventry Reconstruction Co-ordinating Committee.

CARTERS (MERCHANTS), Ltd., inform us that, following the death of their chairman, Mr. Harold E. Carter, Mr. A. P. Hinton, who has been a director of the company since its inception, has been appointed chairman; and Mr. R. F. Bradley and Mr. Norman King have been appointed joint managing directors.

THE London, Midland and Scottish Railway announces the following appointments:—Mr. J. Eliott, District Engineer, Abergavenny, to be District Engineer, Barrow-in-Furness; Mr. I. R. Fraser, District Engineer, Inverness, to be District Engineer, Perth; Mr. A. McIntosh, Assistant, Maintenance of Way and Works, Divisional Engineer's Office, Glasgow, to be District Engineer, Inverness; Mr. W. Bryson, Assistant (Signals), Signal and Telegraph Department, Glasgow, to be Divisional Signal and Telegraph Engineer, Glasgow; Mr. E. Pugson, to be Principal Assistant to C.M.E. for C. and W. Works; Mr. C. W. Foxley, to be Works Superintendent (C. and W.), Derby; Mr. J. E. Bagguley, to be Assistant Works Superintendent, Crewe; Mr. T. A. O'Neill, to be Assistant to Works Superintendent (Planning and General), Crewe; and Mr. E. J. Larkin, to be Assistant Works Superintendent (Locomotive), Derby.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### Institute of Metals

*Thursday, September 4th.*—Junior Institute of Engineers, 39, Victoria Street, Westminster, S.W.1. "Developments in Powder Metallurgy," W. D. Jones. 6 p.m.